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THE UNIVERSITY GRADUATE AND INDUSTRY

IN 1948 Dr. P. Dunsheath, in his book "The Graduate in Industry", set out to explain the opportunities which a career in industry offers to the university graduate, and to discuss the bearing of university teaching on the fitness of university graduates for an industrial career. Since then, relations between the universities and industry in Britain have grown steadily closer; five conferences on the subject have been arranged by the Federation of British Industries, four of them dealing solely with such problems, and the Congress of the Universities of the Commonwealth last year also discussed the matter. The relationship of the universities to industry has also been considered by the Advisory Council on Scientific Policy, and by two of the productivity teams which the Anglo-American Productivity Council sent to the United States.

Nevertheless, in 1952 the Advisory Council on Scientific Policy could still refer, in a report on the man-power situation in regard to scientists and technologists in Britain, to the lack of knowledge, both among parents and teachers, of industry and the careers it could offer. Quite apart from the prejudices against an industrial career, on which trenchant comment has been made in the House of Lords and elsewhere, it is clear from similar comments in relation to the shortage of science teachers that neither ignorance nor prejudice has yet been dispelled. At the Federation of British Industries Conference at Ashorne Hill in October 1952, the responsibility of industry for explaining more fully, to students and their parents, as well as to the universities, the nature and opportunities of a career in industry was freely recognized.

Two handbooks which have recently been issued by the Federation of British Industries may be said to be the outcome of that Conference*. One of these, "A Career for the Graduate in Industry", is intended for the university student and is being distributed to universities and schools to encourage students to apply for industrial posts. The Federation estimates that 20 per cent of the staff posts in industry are open to graduate competition, and the booklet describes to the undergraduate very briefly what industry is and how it works, indicating something of the opportunities which it offers both to the science graduate and the arts graduate. The pamphlet is not intended as more than an introduction: the undergraduate seriously thinking of an industrial career must make his own further inquiries, but he is given more than a hint how to set about them.

What the handbook purports to do it does admirably. The undergraduate is given a clear idea of the qualities which industry will look for in its recruits from the university—whether they possess an arts degree or a science degree—the prospects industry can offer, and the contribution which the university mind can bring to industry. There is a glimpse of

* Federation of British Industries. A Career for the Graduate in Industry. Pp. ii+24. Industry and the Graduate. Pp. ii+31. (London: Federation of British Industries, 1954.) 2s. each.

the vocational satisfaction which is to be found in an industrial career, and a note on salaries enables the prospective entrant to assess salary prospects in comparison with those open to him elsewhere. In producing this handbook, the Federation of British Industries has done a useful job with imagination and a sense of proportion, and it should meet a need to which attention has been frequently directed in recent years. The second handbook, "Industry and the Graduate", which is being distributed to all member firms of the Federation of British Industries and its affiliated trade associations, also meets a declared need on which strong comment has been made in connexion with the utilization of existing scientific and technical knowledge by industry. The pamphlet is written to bring home to industry, and particularly to firms which do not at present employ university graduates, even in science or technology, the importance of a high standard of education and personality in management, and the increasing extent to which industry to-day must recruit from the university if it is to obtain its proper share of the ablest young men and women in successive generations of school-leavers. That task is also very competently done, but the pamphlet also raises a number of fundamental questions, some of which are commonly ignored in discussions of this subject.

Discussing, for example, the educational changes affecting industry and, in particular, the disappearance of the financial barrier to university education, the pamphlet quotes figures to illustrate the serious extent to which industry's direct recruitment of the cream of school-leavers is now limited. Accepting the view, based on studies of the variation in intelligence over the community, that only about 9 per cent of boys of eighteen (having intelligence quotients of 120 or more) are generally suitable for senior posts of leadership—a standard about that required to obtain an honours degree—of 379,700 boys attaining the age of eighteen in 1912, some 34,173 would be suitable for leaders. For 1951, the corresponding figures are 305,700 and 27,513; but whereas in 1912, only 4,000 went to a university, 16,537 did so in 1951.

Thus while the number of those entering a university multiplied four times in the period, the number of school-leavers of the degree of intelligence which is desirable in leaders in any walk of life remaining for all types of employment, including industry, fell in the same period by almost two-thirds, from 30,173 to 10,976. If, moreover, we go further and consider the top 5 per cent in the intelligence-range, the situation is even worse. In 1912, out of 18,985 such school-leavers, some 14,925 were available for direct employment, whereas in 1951 the 15,285 school-leavers in that range were fewer than the university entry and none could be deemed available for direct industrial employment.

This situation is the direct result of the present otherwise admirable social doctrine in Britain that no barrier to higher education shall remain in the path of any young person who has the ability to profit by it. In spite, however, of the increasing tempo with which the most intelligent section of our youth is creamed off to the university, there will undoubtedly continue to be a few exceptions; but industry clearly can no longer rely on recruiting, from those left in the pool at the school-leaving age, boys and girls who possess the intelligence and the character desirable for leadership. To do so, the pamphlet suggests, is to risk disaster.

It may well be for consideration whether it is in the national interest to encourage all the more intelligent boys and girls to enter the universities, irrespective of whether they really desire a university education or are qualified, not so much intellectually as in other ways, to profit by a university education. It is obvious that the universities themselves are facing fresh problems from the change in the social structure represented among their students, quite apart from those arising out of the increase in the number of students. The ability to profit by a university education does not depend solely on intellectual ability, though without a certain level of intelligence a student clearly will be wasting his time at a university.

There is a problem here which merits further examination and on which the studies now being pursued by the University Grants Committee and also by Political and Economic Planning may in due course throw some light. It is, moreover, in this context that we should consider the possible exception to the selection process noted in this handbook. The incidence of the means test for the award of grants, coupled with income tax at its present rate, makes it impossible for the man with £1,500 a year or more to send more than one child to a university without great sacrifice in his standard of living. Even to send the first child involves considerable difficulties; and the pamphlet rightly suggests that the university stream is losing some good material. It should be noted, moreover, that the material that is being lost for such reasons is of a quality which, coming from homes where a tradition of culture and reading and good conversation is probable, might help to balance a deficiency which the University Grants Committee has already noted as causing difficulty in the universities. It is perhaps doubtful whether, as Dr. Eric Ashby has suggested, the universities have fully accepted the new responsibilities which these social changes entail. Even, however, when the universities have satisfied themselves as to the best methods of meeting these responsibilities and made the appropriate provision, there are other implications both for the nation in general and for industry in particular.

It cannot be accepted without further question that it is in the interest of the nation that so many students should go to a university at the public expense, not because they want to be scholars or professional men, or indeed to receive higher education at all, but purely because they are among the top 9 per cent of the nation's intelligence. There is still something to be said for a sense of vocation, and it is at least arguable that public money is spent to the best advantage in helping young people to qualify themselves for an occupation which they really desire to pursue. It does not even follow that all the nation's top intelligence will fructify best

through university training, and it is still true that what is easily come by is apt to be correspondingly lightly esteemed.

That is one side. There is yet another, and two points made in the Federation of British Industries pamphlet bear closely on it. First, it will be noted that even in discussing the opportunities open to the graduate in science or technology, stress is laid upon the value of wider culture and informed opinion, in addition to detailed technical knowledge of the manufacture and performance of products, among representatives of a firm, particularly in overseas markets. Such qualities are fully as desirable among graduates, either in arts or in science, who seek to enter industry on the non-specialist or administrative side. Second, in advising on the recruitment of graduates, the pamphlet deprecates laying too much stress on academic distinction. It should not be taken for granted that only the first-class honours graduate is useful to industry. For many positions a man with second-class honours may be even more desirable, and for many others the graduate with a pass degree may be entirely adequate. Often, it is pointed out, the man who has been active in sport, debating society or other non-academic activity possesses qualities which more than compensate for any shortcomings in formal academic qualifications.

Something more is thus involved than the question whether the selection process is being pushed so far that the nation is not getting full return for the public expenditure involved. If indeed university education still satisfies Macaulay's criteria and opens, invigorates and enriches the mind, the waste is unlikely to be serious. Even, however, from the point of view of an industrial career, something more is rightly to be expected of a university graduate than clarity of thought and intellectual curiosity. Originality of thought and intellectual honesty, receptivity to new ideas, the capacity to assess evidence dispassionately, a sense of values and especially human values, and the ability to take the advice of experts and then to reach a decision—all these qualities are of prime importance to industry, especially on the managerial side; and provided the raw material is there, they can be developed by a university education.

The proviso is important. It is the real reason for viewing with concern the possibility that the universities are still missing some good material, as already suggested. Such material is at least as likely to possess the further qualities of integrity, intellectual and moral courage, and it is the more likely to use to the full the opportunities which a university affords of developing the extra-academical qualities than those who are channelled to the university purely on intellectual grounds and with no particular urge or sense of vocation. Often, indeed, it is the excessive importance attached to academic distinction by home influences, coupled with the denial of real opportunities for home and vacation study, rather than the indifference of the student, that is responsible for failure to profit to the full by the opportunities of a university life.

Increased university awards or maintenance grants are not in themselves the answer to this problem. If university standards are to be maintained, there must at least be example as well as precept, and that is one reason for giving very careful consideration to Mr. J. F. Wolfenden's argument that the universities would be doing a greater service to the community at large if they admitted to some of their places the young people who would be the leaders in other walks of life in addition to the learned professions, in place of some who are admitted to-day. The casualties might be no higher, and even those who failed would carry away something of value and might well have enriched university life. Otherwise there is more than a probability that the process of creaming off high intelligence to the university will involve also a levelling down, and that the equality of man will be realized at a low level rather than a high level.

Now Whitehead, in considering particularly the function of the university in preparation for a career in business or industry, has stressed also that here, too, that function is to promote the imaginative acquisition of knowledge, and he points out that the learned and imaginative life is a way of living. The combination of imagination and learning requires some leisure, freedom from restraint, freedom from harassing worry, some variety of experiences, and the stimulation of other minds diverse in opinion and diverse in equipment. Such conditions are not to be secured by purely financial means: there is also involved an attitude of mind, an outlook, an awareness of opportunities and a sense of proportion that it is difficult for the student to acquire if he comes from a home or a section of society where the purpose and functions of a university are not understood, or the whole climate of opinion has no conception of culture or the wealth and richness of human experience.

Dr. Eric James and Lord Montgomery may well be right in their emphasis on the importance of closer attention to the requirements of the really gifted student, who is destined to fill the highest posts when he reaches maturity. It may be essential to select early and to train such students specially; but on the argument itself they are a small class, and if they must be taught in small classes, industry will still in the main be concerned with recruiting its appropriate share of the top 9 per cent of the intelligence range. The problem remains of ensuring that that intelligence is so educated and trained, either before it enters industry or within industry itself, as to encourage not simply intellectual ability but also personality. It is the all-rounder with initiative and character, and not just professional training, technical knowledge, or academic distinction that industry most needs to-day. The Federation of British Industries has challenged its members to seek the talent they need in the quarters where it is increasingly most likely to be found. The pamphlet on "Industry and the Graduate", however, is an even more searching challenge to clear and constructive thought as to exactly where our present system of university awards is taking us, and whether some fundamental changes in the general attitude and

thought about universities may be required. It may be that the present process of channelling so high a proportion of the nation's intelligence into the universities at the public expense needs reconsideration to ensure that we obtain the full benefit of such expenditure, and that there shall be no disastrous levelling down not merely in standards but also in talent, in enterprise and in vision.

RATS, MICE AND MEN

Control of Rats and Mice

Edited by Dennis Chitty and H. N. Southern. Vol. 1: Rats. Pp. xxxii+306+4 plates. Vol. 2: Rats. Pp. xvi+307–532+4 plates. Vol. 3: House Mice. Pp. xiv+226+8 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 105*s*. the set.

IT has taken a Second World War to provoke a systematic study of those familiar commensals, the common rat and the house mouse. Now, they are being extensively investigated, both as pests and as animals in their own right; but before 1940 most of what passed for knowledge of rat or mouse biology consisted of myth or moral tale. Control, mostly ineffective, depended on alluringly advertised proprietary baits or contraptions, devised without any basis of critical research. The researches described in the three well-produced volumes under notice were carried out by members of the Oxford University Bureau of Animal Population, from the outbreak of war in 1939 to July 1947. Publication was not allowed during war-time and has been made possible now only by a private donation—a curious reflexion on the arrangements available for the dissemination of valuable knowledge. Much unpublished matter remains, and this is deposited at the Bureau.

Despite the delay, this is an important contribution to our knowledge of the biology of *Rattus* and *Mus*, and to the methodology of controlling their onslaughts on our food and our health. The first two volumes deal with work on rats, principally the common brown rat, *Rattus norvegicus* Berkenhout, but with some material on *Rattus rattus* L. The topics include the nature of the poisons used against rats; the biology of rats in relation to control methods; special observations on feeding behaviour; and some operational studies, including an account of experiments on rat control in Palestine and the Sudan. Each section reviews other relevant findings, notably from American work which, too, was stimulated by war; each has a bibliography. Some of the investigations described are inconclusive, and there are many loose ends; but bringing together such a body of work—an unusual enterprise, and one which might be copied elsewhere on a smaller scale—enables the many biologists and others interested in applied research and its organization to see what is involved in the investigation of three related pest species. On this general point, the introduction by the director of the Bureau, Charles Elton, is particularly worth study.

The procedures recommended for routine control by men with little training are necessarily highly simplified. D. Chitty and others show how laborious was the research which lies behind now familiar techniques such as prebaiting and change of bait and poison, and the actual selection of the poison and its concentration. About one thousand field tests, each usually lasting several weeks, were carried out, and some hundred tests were made on rats in cages. The results are, however, of interest to others besides the rat-catcher, the warehouse-keeper or the medical officer. These volumes contain original data on the closely observed behaviour of feral rats and mice—data of a kind which could not have been obtained from experiments on laboratory varieties. In its present form this information is adequately related neither to current ethological field studies nor to the psychology of white rats, and it presents a notable challenge to the student of mammalian behaviour. There is very full information on what the authors call 'new object reaction' in rats—an (innate?) avoidance behaviour or 'neophobia' which clearly has much to do with the success of these animals. There is also information on poison 'shyness' or the refusal of a food which has caused illness—a phenomenon which should stimulate further study of the abilities of rats to select an advantageous diet.

On the ecological side, much has been learnt of rat population dynamics. Part of this work has been separately published; in these volumes the data on the growth and decline of rat numbers in different circumstances are scattered among several chapters, and are mainly related to assessing the effects of attempts at large-scale control. A. D. Middleton, for example, describes operational research on rat control on a group of farms—an encouraging instance of what can be done, at reasonable cost, with sound planning; and Elton and Laurie describe a sample census of rats and mice in corn-ricks in England, with results much less encouraging for those concerned with rural rat control.

The study of what actually happens to pest populations when control is attempted, in relation to the amount of damage they cause, is an essential basis for a rational system of control. The Bureau's findings make a useful starting-point for future operational research, but important generalizations on this topic are scattered through various chapters, or made only by implication: there is no point at which the threads of the argument on rat numbers are brought together in a unified statement.

There is greater unity in the third volume, on *Mus musculus* L., since the final writing was almost wholly the work of the editor, H. N. Southern. It was only with the Second World War that the house mouse was found to be a serious agricultural pest in Britain, but surveys from 1940 on showed it to be abundant on farms and highly destructive in ricks. In grain stores, of course, its activities can be devastating. Its behaviour is markedly different from that of the common rat: while the latter is conservative but 'suspicious', the mouse is mercurial and unpredictable. The Oxford work on this species has produced, for the first time, a sound basis for control by poisoning or trapping, and also a foundation for future studies of mouse biology.

The scientific worker on pest control must often, necessarily, be a jack-of-all-trades, though perhaps not necessarily with the proverbial corollary. Eight years of research by a team of such workers have, as would be expected, produced results of value to biologists working in a number of diverse fields, both 'pure' and applied. It is to be hoped that these volumes will be correspondingly widely used.

S. A. Barnett

ANALYSIS BY CHROMATOGRAPHY AND ION EXCHANGE

Inorganic Chromatography

By Orsino C. Smith. Pp. x+134+5 plates. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 37*s.* 6*d.* net.

Chromatographic Methods of Inorganic Analysis

With Special Reference to Paper Chromatography. By Dr. F. H. Pollard and Dr. J. F. W. McOmie. Pp. viii+192+4 plates. (London: Butterworths Scientific Publications, 1953.) 30*s.* net.

Ion Exchanges in Analytical Chemistry

By Prof. Olof Samuelson. Pp. xviii+291. (New York: John Wiley and Sons, Inc.; Stockholm: Almqvist and Wiksell; London: Chapman and Hall, Ltd., 1953.) 52*s.* net.

IT is natural enough that, when subjects assume such prominence in scientific research as ion exchange and chromatography, there will follow attempts to systematize the known facts by the publication of text-books. These three books should be considered against the background of the vast amount of unco-ordinated data to be found in the scientific journals. The only reasonable answer to the problem is for the text-book writer to confine himself to a portion of the subject, and to avoid so far as possible the tedious repetitions to which the reader is constantly subjected.

Mr. O. C. Smith, clearly, is overwhelmed with the complexity of his subject, as this sentence from p. 96 of his book, "Inorganic Chromatography", shows. "In this work many combinations were found to exist, and where several factors are present they are a multitude; for instance, whether the solution is acid, neutral or alkaline: type of solvent: type of adsorbent: kind of reagents and whether the developer is used before the sample or after: and ad infinitum". This has, no doubt, led him to overlook the almost complete unintelligibility of the last sentence of his paragraph on "Adsorption on Paper" (p. 5). In his discussion of "Apolar Adsorption" (p. 9) he does not distinguish between alumina and silica, which are normally regarded as instances of adsorption and partition, respectively.

Chapter 4 of his book suffers from the arrangement: the paragraphs are headed by authors' names instead of subjects, and constant reference to the index is necessary. In Chapter 5, although most paper chromatography has been done on filter paper *per se*, he begins by a description of the preparation of alumina-impregnated paper, which is a special case. Chapter 8, "Laboratory Procedures", is useful, but would have been better if more attention had been paid to the standardization of adsorbents. There is no attempt to describe alumina in chemical or physical terms, and, as variable amounts of water are added and the initial activity is not stated, it is possible that the activity is varying throughout an experiment. The packing of a column by a wet slurry process will not necessarily give the same results as a dry column. Magnesium silicate is difficult to define chromatographically, and as Mr. Smith himself states in relation to starch (p. 118), the results obtained with different batches of material are not always reproducible.

As regards the other two books, by Drs. F. H. Pollard and J. F. W. McOmie and by Prof. Olof Samuelson, respectively, the exposition is clear and the presentation logical. Pollard and McOmie give a review of inorganic chromatography which is as comprehensive as is possible on a subject that receives additional published researches daily. There are occasional slight obscurities; thus, the table of "Order of Adsorption" (p. 7) is too compressed and the word "column" in the text is ambiguous. The new qualitative analysis schemes are ingenious and sound; but before the 'classical' analysis is scrapped we should ask ourselves whether there is, in fact, a real advantage in the chromatographic method. It may well be that many laboratories will adopt some part of the scheme as a supplement to their normal methods, and in this case they will find the tables in the appendix of Pollard and McOmie of great help.

Ion-exchange materials form the subject-matter of Prof. Samuelson's book, and with these substances the analyst is completely in the hands of the manufacturer. It is a good sign for Anglo-American co-operation that the tables (pp. 261–264) list ion exchangers of British and European manufacture as well as those of American origin. It is clear that a selection of examples must be made if the book is not to reach encyclopædic size, and therefore specialists in subjects such as alkaloids and proteins may find the information too sparse; however, a reasonable bibliography points the way to further sources.

The book by Pollard and McOmie and that by Samuelson should find a place not only in every technical library but also at the practical analyst's desk.

E. Q. Laws

INTRODUCTION TO VECTOR AND TENSOR ANALYSIS

Vector and Tensor Analysis

By Prof. G. E. Hay. Pp. viii+193. (New York: Dover Publications, Inc., 1953.) 2.75 dollars, cloth; 1.50 dollars, paper.

THE emphasis in this book is mostly on vector analysis, which is covered by five chapters, whereas but a single chapter is devoted to tensors. This, I think, is unfortunate for three reasons: published studies in vector analysis have already been considerable; tensor analysis is the generalized and therefore broader aspect of the vector–tensor approach; and there is a far greater need for an elementary-to-intermediate standard of book on tensors really suited to beginners working in the applied sciences. Moreover, in respect of tensors particularly, it is likely that there will be some measure of disappointment in engineering circles that the book is confined to the classical approach instead of supplementing the latter by the method initiated and developed by Gabriel Kron primarily for engineers. The point is worth making because there should be a greater measure of mutual recognition by pure and applied scientists of each other's needs and aspirations, coupled with effective joint action to obtain the best of both worlds.

Chapter 1 describes elementary vector operations up to the level of differentiation and integration with respect to a scalar variable and to linear vector differential equations. Chapter 2 gives applications of vector principles to solid analytic geometry and to differential geometry. Chapter 3 relates to the application of vectors to mechanics within the scope of motion of a particle and of a system of particles.

Chapters 4 and 5 deal with partial differentiation and with integration respectively and include studies of the del operator, line, surface and triple integrals, Green's and Stokes's theorems, and irrotational and solenoidal vectors. Chapter 6, on tensor analysis, dismisses the subject in a mere thirty-seven pages, but nevertheless it manages to present a concise account of the main essentials of the classical approach. For example, it includes co-ordinate transformation, covariant, contravariant and mixed tensors, the metric and conjugate tensors, lowering and raising indexes, the Christoffel symbols, and the curvature tensor, in addition to stating other topics of a kindred nature.

There are 195 problems (without answers), and although the book is said to be for students of engineering and mathematical physics, one can scarcely imagine that many of them will find much satisfaction from solving the problems except as exercises in pure mathematics. The type-setting and printing are excellent, but the work bears some evidence of hasty proof-reading. Considered as a condensed text in the classical manner, the book can well be recommended; and while it may help the embryo mathematical physicist, I much doubt that it will do the same for the young engineer.

S. Austen Stigant

FOOD FROM FRESH WATERS

Fertilizers in Fishponds

(Colonial Office, Fishery Publication No. 5, 1954.) By C. H. Mortimer. With additional material and a foreword by C. F. Hickling. Pp. iv+56. (London: H.M.S.O., 1954.) 25*s*. net.

It is often remarked on the Continent of Europe that in Britain scarcely any freshwater fish are exploited for food. Indeed, many who went to Britain during and after the Second World War investigated the possibility of carp farming on the German model. But sea fish is so readily available everywhere in the British Isles and, if truth be told, so much more palatable than carp, tench and pike, that it seems unlikely that such an industry could be established, even if the summer climate should prove to be warm enough to allow farmed fish to attain an economic growth-rate.

Nevertheless, during the War we had to consider to what extent our own fresh waters could contribute to our food supply, and Dr. C. H. Mortimer prepared for the Freshwater Biological Association a bibliography of publications on the use of manures to increase the productivity of fish ponds. In the event, we never had to exploit our fresh waters, so this paper did not attract the attention it deserved. Soon after his appointment as fishery adviser to the Colonial Office, Dr. C. F. Hickling appreciated the contribution freshwater fish could make towards remedying the serious protein deficiency that exists in so many tropical and sub-tropical countries and, by example and precept, has aroused an interest in fish farming throughout the British Colonies.

The literature on the subject is scattered and scanty, so no doubt Hickling found Mortimer's bibliography useful, with the happy result that they have collaborated to revise and extend the earlier publication and have produced a paper that every fish farmer and every freshwater biologist in the world should have. It is a very good bibliography, but it is a great deal more than that. The first forty pages are in fact a critical review of the literature and are most readable and informative. Then follow 108 pages which contain 351 references, and in every case where the title of the paper is not an adequate description of it there is an abstract. These abstracts vary in length from one line to rather more than four pages, and the long summaries of the most important publications are sometimes illustrated by graphs and tables. So the reader may find the information he needs in the abstract and can certainly discover whether the full paper is worth consulting—a very important matter in parts of the world remote from libraries. Lastly, there is an adequate index, making the publication handy to use.

H.M. Stationery Office ought surely to issue publications of this kind in something more durable than a paper cover. This book will be in constant use and will inevitably have to be given a permanent binding, so why should not the publishers do their job properly?

F. T. K. Pentelow

PROPERTIES OF MATTER

Properties of Matter

By H. N. V. Temperley. Pp. vii+323. (London: University Tutorial Press, Ltd., 1953.) 21*s*.

An outstanding feature of this excellent book by Mr. H. N. V. Temperley, which is intended for the degree student, is its emphasis on essentials. The usual descriptive matter is greatly condensed; indeed, only one experiment (the determination of g) is described in full, but this is done in great detail to illustrate the general principles of correcting for experimental error. The reader is left to supply for himself (guided by a mathematical appendix) the intermediate steps in the derivation of formulæ; and the author deals very thoroughly with the applications of classical mechanics to the behaviour of solids, liquids and gases.

The book is interesting to read for two reasons. The first is Mr. Temperley's graceful economy of words; an author who is as careful of his writing as of the subject-matter compels attention, besides setting a good example. The second is his outlook; for, as he says, although no especially striking advance has taken place in the twentieth century in the field of classical physics, there is no sign of any slowing-down of progress, quite the reverse, and the subject is still a very long way from being a 'closed' one. He gives many examples of the recent applications of classical physics—work at very high and very low pressures, ultrasonic absorption and the second coefficient of viscosity, the propagation of shock waves, and the behaviour of metals under plastic flow, to mention a few. The effect of this is to assure the student that classical physics is not only the grammar of the subject that he must master, but is also in its own right a living branch of the subject, with a future as well as a distinguished past.

Each chapter has a bibliography and examples for solution, and there is a collection of examination questions, chiefly from Part I of the Cambridge Natural Sciences Tripos and the London B.Sc. examinations. One's only criticism is of the publisher's modest statement that the book is suitable for students preparing for degrees in science; it would be fairer to describe it as invaluable for degree students preparing to be scientists.

G. R. Noakes

THE UNIVERSITY OF HULL

By Prof. BRYNMOR JONES
Pro-Vice-Chancellor

ON May 13, 1954, H.M. the Queen granted a Charter constituting and founding a University within the City and County of Kingston upon Hull under the style and title of "The University of Hull", and so came into being the third new university to be established in England since the end of the Second World War—the others being Nottingham (1948) and Southampton (1952). In the years between the two Wars only one university, Reading (1926), was created, and it is necessary to look to the early years of the century for a precedent for the creation of so many universities within a space of a few years, when Bristol and the mid-northern universities were founded.

The English civic universities are largely a product of the twentieth century. Their growth, both in number and in the variety of their teaching and research departments, reflects the great expansion in the opportunities for higher education and for specialized studies in the past half-century; while their standing to-day among the universities of the Old and the New World is an incentive and an encouragement to those new foundations which have been added to their number in recent years. Although it is natural and desirable that each university should derive much of its ethos from its immediate surroundings, the newer institutions must, if they are to prosper and grow, strive to take their rightful place as national institutions.

Foundation and Development of the University College

Until the University College of North Staffordshire was established in 1949, the University College of Hull was the youngest of British university colleges. It was founded in 1927 with a gift of £250,000 from the late Right Hon. T. R. Ferens—but for his munificence and vision, and his concern to establish a centre of higher education in the city where he lived and prospered, there would not be to-day a university to enrich its life and to illume the plain of Holderness. But while Thomas Robinson Ferens is rightly acclaimed and honoured as the founder, the new venture would have been more tardy in its growth, and less attractive in its appeal, if it had not been fortunate in winning generous support from other quarters—in particular, from the City and County of Kingston upon Hull and from Mr. G. F. Grant, a prosperous leather merchant and a close friend of the founder. The City Council gave a sum of £150,000 for the first two buildings—one housed the arts department and the administration, the other the scientific laboratories, the library, the assembly hall, and the refectory. These were erected in 1927–28 on land given originally by Mr. Ferens to the City, and transferred by the City Council to the College. The choice of the site on Cottingham Road for the new College was a most fortunate one, for adjoining it was a large area of open land. This the Council of the College gradually acquired, so that when the opportunity for rapid expansion came at the end of the War, the College had some seventy acres of pasture-land available for new buildings and sports fields. In addition to the capital sum for buildings, the City Council agreed to make an annual grant, and so did the Education Authorities of the East Riding, Lindsey, and Grimsby, and the endowment of the College was enlarged by a bequest of about £100,000 by Mr. G. F. Grant. A number of special gifts and bequests were received both for general and particular purposes, and especially for scholarships. In this, too, the College was fortunate, for in those days grants and scholarships were less numerous than they are to-day—indeed, it was not uncommon for potential students to move from one university examination hall to another, in the hope that by their learning they could win enough in the way of scholarships to keep them at the university.

Some thirty students registered for the first session in 1928. Gradually their number grew, but only in one year before the War did the student-body exceed two hundred. Although on the outbreak of the Second World War there was not, as in the First, the same precipitate exodus of university students to join the Forces, the number of students in the College soon began to fall, and, as the City increasingly became a favourite target for enemy aeroplanes, the number of students fell back to a hundred. At one period plans were made for the organized migration of these to a less vulnerable part of the country: fortunately, the need for this never arose, and, despite the severity of the raids on the City, the College escaped serious damage.

At the end of the War, the College began to prepare for the difficult years ahead. It soon became clear that the pressure for places at the universities would be great, for in addition to the normal complement of students from the schools, there were many thousands of ex-Service men and women to be accommodated. To meet this great influx of students the Government asked all university institutions to admit as many students as possible. Although, in the absence of faculties of medicine and engineering, the College could not offer teaching in so wide a range of studies, it realized that it could offer ample opportunities for study in its two faculties of arts and pure science. Unlike most universities, it had land for new buildings and, of more immediate value, it had accommodation in existing buildings for many more students than were housed in the 'thirties. This was especially true of the humanities and of law, the requirements of which fortunately are so much simpler than those in science.

The potentialities of the College were quickly recognized by the University Grants Committee, some of the members of which visited the College in the spring of 1945, and in the summer of that year the College became eligible for the first time for Treasury grants both for revenue and capital purposes. In the following eight years the capital grants from the Treasury for new buildings, the purchase and adaptation of existing ones, the erection of temporary accommodation, and the provision of furniture and equipment for teaching and residential needs, amounted in total to well over a million pounds. In about the same period the number of full-time students at the College rose from the region of a hundred in 1944 to a peak of 917 in 1950–51—a

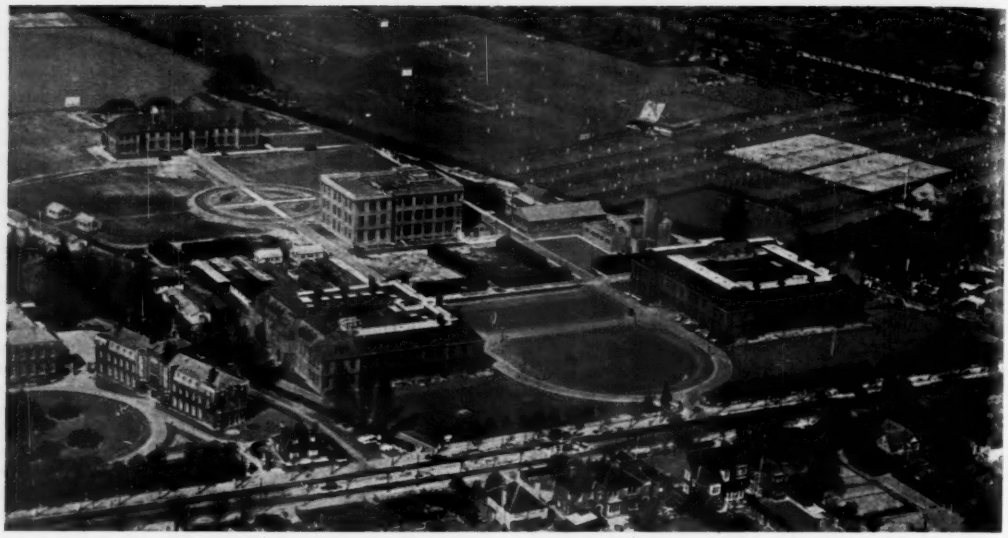

Fig. 1. Aerial view of the University of Hull. Centre block, new Chemistry Laboratories; right quadrangle, Science Buildings; left quadrangle, Arts and Administration; back, Students' Union. By kind permission of the *Hull Daily Mail*

total made up of 584 men and 333 women. In addition, many students were registered for part-time courses for diplomas and certificates, while some three thousand adult students each year attended evening classes and lecture courses both in Hull and in a large number of centres throughout the College area. An extensive scheme of tutorial classes and lectures for members of H.M. Forces was arranged by the Department of Adult Education in conjunction with Service Departments, and financed by a special grant from the War Office. To meet all these needs, the staff of the College was greatly enlarged. It now numbers about 135. Of these, twelve are engaged as tutors in adult education, and together they provide teaching in English, economics, history (including local history, and history of art), literature and drama, philosophy and psychology.

To meet pressing demands for accommodation, a number of temporary hutments were erected, and several of these were equipped as laboratories. While the furniture was of the best materials available at the time, the huts themselves were designed to serve for a limited number of years, for previous experience had shown that, in universities in particular, 'temporary' accommodation can all too often become permanent. Useful as these temporary laboratories have proved to be, they are no substitute for the well-built and well-equipped laboratories which teaching and research in modern science demand.

As licences were granted and building materials became available, work was started on permanent accommodation. The first was an addition to the original Arts building. This comprised in the main a number of lecture rooms for classes in the humanities; but it also allowed of an appreciable extension of the Department of Botany, which from the first days of the College had been housed on the top floor of the Arts building. The addition of new teaching and research laboratories, a lecture theatre, a herbarium, and some staff rooms has allowed for a welcome expansion of botanical studies. The Department has, too, a large experimental garden with a number of well-equipped glass-houses, stocked with a rich variety of plants, and especially of ferns.

A students' refectory seating four hundred, served by modern kitchens equipped with the latest mechanized apparatus, was built in 1950, and when this was finished, work was started on a Students' Union building. Together they form one of the most attractive centres for student life and activities in Britain. The Union has separate common rooms for men and women, and an excellently designed and furnished joint common room. In this building, too, is a Students' Council Room with the appropriate offices for Union officers.

The latest addition is the first section of a new science building to house the Department of Chemistry. This has a number of large and well-equipped teaching laboratories, rooms for research in the three main branches of the subject, three lecture theatres, and a large basement for stores. The completion of this building has made it possible to provide more accommodation for physics in the original science building by converting the laboratories used formerly by chemists for the use of physicists. There are two new laboratories for undergraduates, a number of research rooms and an additional lecture theatre. As a result, it was possible last summer to remove some of the temporary hutments. Along with the physical sciences, the biological sciences have also grown, and the Department of Zoology, like that of Botany, has had to be provided with more space. In addition to a new laboratory equipped specially for third-year students, the Department has now an up-to-date animal house and an aquarium. The erection of so many new buildings and the expansion of the work of the science departments have necessitated the building of a large new boiler house and of a modern workshop.

So far it has not been possible to house the Department of Geography in a permanent home of its own—a building for geography and geology is one of the needs of the new University. In the meantime, to cope with the greatly increased numbers in geo-

graphy, a temporary laboratory was built. Of greater significance has been the creation of a chair of geography. The establishment of this new chair is a recognition of the intellectual value and practical importance of the subject, and of the work of the present head of the Department in building it up over a period of years.

When the University College was founded, the Council very wisely decided to establish only a limited number of departments, and to concentrate teaching and research to the major subjects. Thus, the emphasis was laid on philosophy rather than psychology, on geography rather than geology, and on classics, English, French and German as the main languages. But it had always been the intention that new subjects should be added, and new departments established. In the past few years many additions have been made. A Department of Social Studies was started in 1946, and two years later a lectureship in sociology was added. The range of teaching in the faculty of arts has been extended to include theology and music, and provision has been made for the teaching of Finnish and Swedish. Special appointments have been made by the Department of Economics and Commerce in public administration and in government. Geology has been added to the subjects in the faculty of science, and psychology, formerly attached to the Department of Philosophy, has been recently constituted into a separate department with a well-equipped laboratory of its own. Its courses are open to both arts and science students. The establishment of readerships in medieval history and in plant physiology have not only been of value to undergraduates with a special interest in these fields, but they have also helped to encourage research. There has been, too, a very substantial strengthening of the Department of Education, both in the number of its staff and in the provision of specialist teaching—including physical education, which has a modern gymnasium.

Along with the other university institutions, the College established an Institute of Education, with its own special library. It serves to promote the interests of education among those concerned for its practice and its administration in the College area, and it offers opportunities for further study, refreshment and investigation to teachers at all levels.

Research

Along with the expansion in the number of undergraduates, and the provision of more accommodation for teaching and specialist study, there have been welcome additions to the facilities for research in several departments. Considerable sums have been spent on new equipment, and the increase in the number of graduates engaged in research has become an important feature in the life of the College. A large number of research topics are being investigated by members of the staff in both faculties, and by research students working under their direction.

Library

The library, which has grown steadily over the years, was planned from the start as the centre of the academic life of the College, especially in the humanities. It has now some 120,000 volumes. In the first few years its growth was rapid; but, unfortunately, it has not kept pace with the increase in student numbers, or with the needs of specialist teaching and research. In part, this is due to the inevitable restrictions of the war years and to the greatly increased cost of both books and binding in the post-war years. Fortunately, monographs and

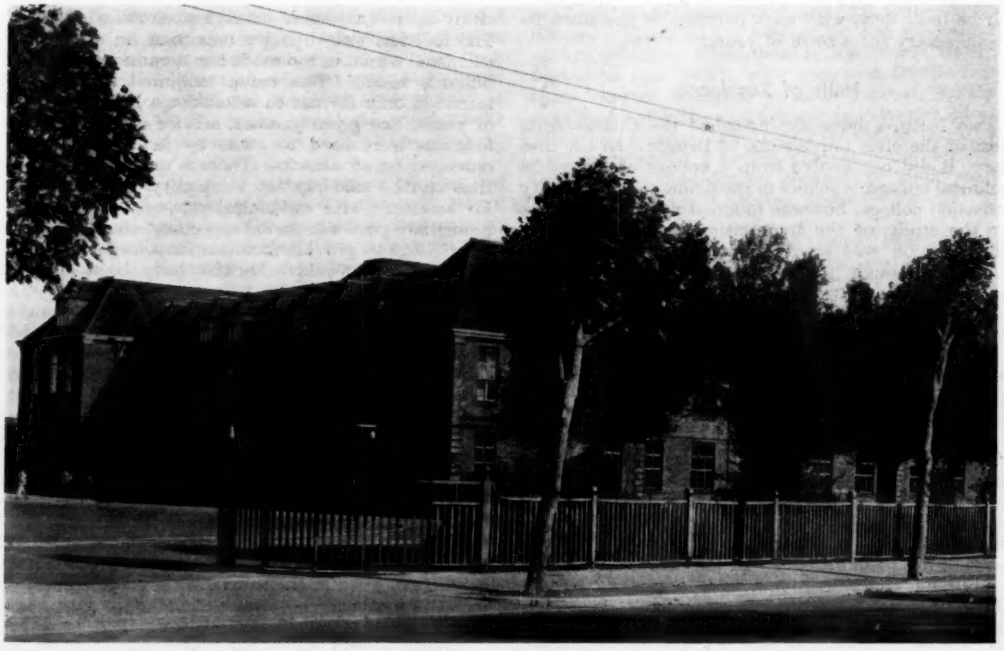

Fig. 2. Science Buildings

Fig. 3. Students' Union and Refectory

periodicals can be obtained on loan with reasonable ease from other university and industrial centres; but the building-up of the library on a large scale remains an urgent and pressing need in the years ahead.

The main part of the present library continues to be housed in accommodation on two floors of the science building intended ultimately for lecture rooms and staff rooms; but plans are well advanced for a new library building. The site for this is large enough to accommodate a building which will ultimately house a million books, and the plans make it possible for it to be built in sections. The stack in particular can be extended as the need arises. The main reading rooms and the rooms for administration will be built first, with such portions of the stack as are necessary for a term of years.

Halls of Residence

Two features have distinguished the College from most of the civic universities of Britain. In the first place, it did not evolve from a college of science, a technical college, a school of medicine, or a university extension college, but was founded as a new venture for the study of the humanities and pure science. No provision was made for medicine or for technology, although the incorporation of these was envisaged as a possibility at a later stage. In the second place, it has from its foundation required residence from all its students, with the exception of a small minority that lives at home. In this it resembles more the first Welsh colleges than the civic universities of England, where the majority of students live in lodgings or at home.

In the first year a hall for men was founded by Mr. F. Needler by adapting a large private house in the village of Cottingham—a distance of some two miles from the College itself. A hall for women was also established in Cottingham in Thwaite House, a large red-brick building standing in twenty-four acres of beautiful grounds. In the 'thirties two wings containing study-bedrooms were added to Needler Hall, to enable it to accommodate sixty-eight students. About the same time, Thwaite House was also enlarged by the addition of a number of separate study-bedrooms. In spite of these additions, both Halls continued to be regarded as temporary in character. The original plan of the College buildings envisaged the erection of halls of residence and athletic grounds adjoining the lecture rooms and laboratories; but, when the population of the College was growing rapidly in the late 'forties, it became clear that in the changed circumstances it would be better to keep the whole of the Cottingham Road site for academic developments. The advantages of this course have become apparent as new academic and social buildings have been erected. Although this has reduced the possibility of creating an academic, residential and athletic campus, it has assured ample space for further academic development, including, should the need arise, accommodation for one or more branches of technology or of medicine.

Once this decision had been reached, extensive additions were made to Thwaite Hall. These included more than a hundred study-bedrooms, a spacious reading room, and a finely proportioned dining hall.

The other hall for women—Cleminson Hall—comprises three large houses which have been adapted and modernized to constitute a hall for sixty-eight women. It has a light and exceptionally pleasant new dining hall, and its common rooms are unusual for the freshness of their decorations and furnishings.

Camp Hall is a temporary venture made up of a hutted camp, designed originally for families whose homes had been damaged in air raids. It has provided accommodation for three hundred men in separate study-bedrooms, each with its electrical heating. The hall has two dining rooms, and, in addition to the usual common rooms, it has a games room and a billiards room. This camp, acquired in 1946 and intended only for use as a hall for a limited number of years, has given yeoman service at a time when lodgings were hard to come by in a city severely damaged by air attacks. There is undoubtedly much that can be said against temporary buildings, both for academic and residential purposes; but in the immediate post-war period especially, they did enable the College to provide facilities for a large number of students who would otherwise have been deprived of the opportunity of a university education. The abolition of a large part of Camp Hall is now in sight, for work is well advanced on a permanent hall for a hundred and fifty men. This is to be known as Ferens Hall in honour of the founder of the College.

Athletics

The first section of an athletics centre, in close proximity to the Students' Union, was completed in 1950. In addition to the usual changing rooms for men and women, there is a squash rackets court. A first-class running track was constructed in 1952, and in the past two years some new records have been established in the course of the national athletic matches which have been held under the auspices of the Amateur Athletics Association.

Tennis courts have also been laid out in the grounds of the Halls at Cottingham.

The University

Such was the inheritance of the University when it was founded in May. The University College had been planned from the first as a university in the making: the Court of Governors, the Council, the Senate and the Boards of Faculties had from the foundation the customary powers. Indeed, it says much for the foresight of those who served on these various bodies in the early years that in the transition to full university status there was, in matters of government and control, so little need for change in established practice.

But in a number of other ways there was inevitably much new ground to be explored and many important decisions to be reached. This was especially true of the degrees to be awarded by the new university. For more than three years the planning of degree courses and syllabuses has been a major pre-occupation of the Senate and Faculty Boards. Before any firm decisions were made, a special Charter Committee set up by the Senate reviewed the degree structures of a number of universities, including those of the University of London, the examinations of which the students of the College have taken for more than twenty years. A number of criticisms and comments from schools and industry were assessed, and the experiments and changes proposed in other universities were borne in mind. The Committee found that it had to try to meet—or to balance—what seemed at first to be competing claims: the need of the country for more specialists in almost all branches of knowledge, and particularly in certain sciences, the dangers of over-specialization, and the plea both from industry and from schools that graduates should not be narrow specialists, but that they should at least be aware of the social problems which make their particular knowledge and skill so necessary in this age.

However well planned, only a part of all this can be covered by degree courses—for the rest, every university must rely on the inspiration of its teaching, on the enthusiasm and self-sacrifice which its staff brings to the discovery of new knowledge and to new ways of thought, and on its corporate life. But since the degree courses themselves must inevitably be the core of the intellectual training, their content and their relationship one to another are of first importance. While it is true that many undergraduates fail to broaden their mental outlook, it is equally true that the greatest single benefit a student can derive from a university education is the enlargement of his ability to go deeply into his chosen field. Such an experience should, and often does, provide a focus from which other and wider interests can readily be developed. Thus, while acknowledging the dangers of over-specialization, the Committee was at the same time alive to the value and importance of specialist training—for one of the main purposes of education is to impart an intimate sense of the value and power of ideas, of the structure of ideas, and of the beauty of ideas, thereby cultivating that most austere of all mental attributes, the sense of style.

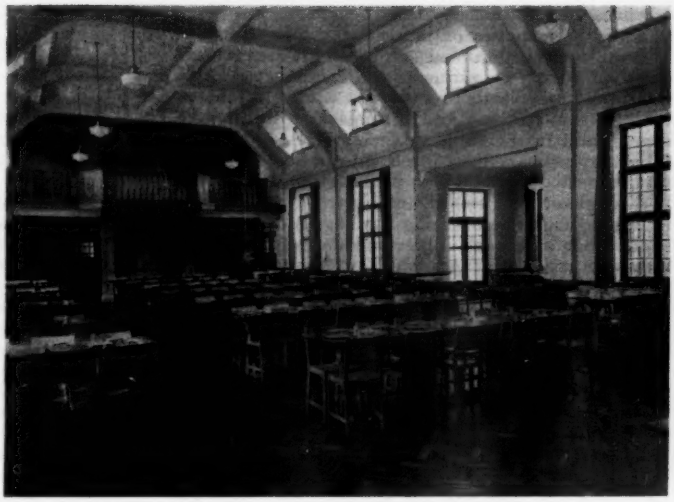

Fig. 4. Dining hall at Thwaite Hall

After careful consideration and discussion, the Senate and Council approved that there should be two kinds of degree—'special degrees' and 'joint degrees'. The special degrees are in one main subject, joint degrees in two main subjects. A 'general degree', with three subjects taken to final year, as in London and some other universities, was rejected, partly because experience has shown that few students reach a satisfactory standard in all three; but more particularly because the great majority of students fail to co-ordinate the knowledge so as to achieve some measure of synthesis. The special and joint degrees are based on the established principle that a student's general education is a matter for the schools. The radical solution of lengthening the course for a first degree to four years, with provision in the first of these courses designed to give a broad survey of existing knowledge and disciplines, was not adopted. While it is true that many students could with advantage spend a fourth year at a university, the extension of first-degree courses to four years is impracticable on financial grounds for the great majority.

The first-degree courses have therefore been planned to occupy three academic years. The whole of this time, however, will normally be devoted to post-intermediate work, since there is no 'intermediate' examination in the usual meaning of that term. The University needs, of course, to be satisfied that candidates have passed the General Certificate of Education in those subjects which will enable them to enter with profit on the degree courses of their choice. In most cases, though not in all, they will need to have a General Certificate of Education in the particular subjects which they propose to read for their degrees; but this does not necessarily mean that they must hold a certificate which will exempt them from the usual type of intermediate examination in three or four subjects. All students must, of course, be qualified to matriculate on terms similar to those accepted by most universities; but what is needed in addition has been determined solely in the interest of degree studies.

All candidates for the B.A. degree, except those offering mathematics or music for a special degree, must take one additional subject—either as a two-year 'subsidiary' or as a one-year 'ancillary'. Within this broad scheme there is a wide variety of choice, both in the combination of subjects for the joint degree, and in the subjects which may be taken at subsidiary and ancillary level. In the final examination, classified honours or a pass may be awarded in both degrees.

The regulations governing the degree of B.Sc. are similar, but with some important differences. Except in mathematics, all candidates for the special degree must take either a two-year subsidiary or two one-year ancillaries. The choice of these is in some instances closely defined, especially where the second subject becomes a tool for the fuller understanding of the main subject. Thus, all students wishing to specialize in physics are required to take mathematics as a subsidiary, and candidates offering philosophy as main subject must take a two-year course in psychology. Specialists in chemistry are required to take mathematics as one of the two ancillaries; but there is a free choice of the second. With the view of broadening the range of a student's reading, provision is made in each faculty for students to opt for any ancillary for which teaching is available in the other faculty. The stage at which examinations for the special degree are held varies with the subject. In some, the final examination will be held in two parts—Part 1 at the end of the second year and Part 2 at the end of the third year. In other subjects there will be one examination at the end of the third year.

Students for the degree of LL.B. take three examinations—a qualifying examination, and Parts 1 and 2. For the degree of B.Sc. (Econ.) the qualifying examination is at the end of six terms, and the final examination at the end of nine terms.

In addition there are many diploma and certificate courses, among them the course leading to the Graduate Certificate in Education taken by those graduates who choose teaching as a vocation.

The degrees of B.D. and B.Mus. rank as higher degrees, and courses leading to them may only be taken by candidates who have a first degree. The University has the power to grant the usual masters' degrees, and here special mention should, perhaps, be made of two such degrees—that of M.Sc. (Econ.) and M.Ed.—for which provision is not made in all universities. Provision has also been made for the degree of Ph.D. and the higher doctorates*.

The new University of Hull looks to the future with confidence. It aims to give to its students a broad and balanced approach to their studies, with provision for specialist training for those best fitted for it. While the larger universities can, in many cases, offer a wider range of study, with a greater variety of specialized courses, there are compensating advantages in a community of moderate size, where personal contacts both with students and with members of staff are more readily established. In the words of Prof. Bonamy Dobrée, the University aspires along with its sister universities to contribute to "the creation, generation by generation in a continuous flow, of a body of men and women who share a sense of civilized values, who feel responsible for developing them, who are united by their culture, and who by the simple pressure of their existence and outlook will form and be enlightened public opinion".

* Full syllabuses and notes on requirements are given in the University's "Prospectus and Regulations".

CENTRE FOR RESEARCH ON MACROMOLECULES, STRASBOURG

THE Centre for Research on Macromolecules (C.R.M.), Strasbourg, is a foundation of the French National Centre for Scientific Research (C.N.R.S.). It is one of a series of specialized institutes each of which is devoted to a particular branch of research, and several of these are planned to be established in the course of the next few years.

This new institute is sited in Strasbourg because there was already in the faculty of sciences a university department for the study of macromolecules, financially supported by the National Centre. It is this nucleus that has been expanded and installed in a new building to become the new national centre for macromolecular studies.

The idea of the foundation, due to Prof. C. Sadron, the present director, is that it would facilitate the collaboration of physicists, chemists and biologists interested in macromolecular science. The physicist's part is the creation and the development of the necessary techniques for the investigation of the constitution of macromolecules by purely physical methods. In order to provide the materials for this work, teams of chemists and biologists are also necessary. Similarly, the physicists provide the finished tools for the use of the chemists and the biologists. In this way the highly specialized and difficult techniques and methods may all be applied so that correct interpretation of the results may be obtained in a very broad and difficult field. To provide for the carrying out of this broad plan, the following facilities and organization have been created.

The building is housed on four floors with a total area of about 35,000 sq. ft. In the basement on the ground floor are special rooms for precise physical measurements, administrative offices and general services. The first floor is devoted mostly to biology, some of the space having accommodation for spectroscopic instruments. The lecture room is also on the first floor and extends to the second floor as well. The second floor is concerned with chemistry and also houses the private apartments of the director.

The present staff consists of about sixty research workers, technicians, mechanics, secretaries and typists.

The physics section consists of about eleven people. It is directed by Prof. H. Benoit and is concerned with light scattering, Brownian diffusion, streaming birefringence, viscosity, fluorescence and dielectric constant as well as supersonic work. Infra-red and ultra-violet spectroscopic work are also the concern of the physics section.

There is also a separate section of X-ray studies with seven people directed by Dr. V. Luzzati. The topics here comprise the determination of molecular structures by conventional diffraction methods, the crystallinity of fibres and low-angle scattering by high polymer solutions. A Spinco ultracentrifuge and an electron microscope complete the equipment.

The biological section, directed by Dr. Vendrely, consists of ten people, and the two main topics are the structure of globular proteins and also the study of nucleic acids.

The chemical division is directed by Prof. J. Parrod, assisted by Dr. P. Rempp. It comprises two sections, the first being concerned with the synthesis of macromolecules of low molecular weight with a

well-defined constitution, and the second with the study of polymerization reactions. Facilities for fractionation are also available in this section, and the particular concern of the polymerization section is elastomers.

The laboratory was formally opened on October 6. The ceremony was presided over by the Secretary of State for Scientific Research and Technical Progress in the presence of M. G. Dupouy, member of the Institut de France and director of the National Centre for Scientific Research, representatives of the Ministry of Education, and numerous personalities, French and foreign, belonging to the world of science and industry. An international colloquium was arranged on this occasion and some fifteen papers were given by eminent specialists on various aspects of the science of macromolecules. The colloquium was concerned not only with physics, biology and chemistry, but also with considerations of the industrial uses of high polymers, which come under the general care of the new Centre.

The Centre for Research on Macromolecules will therefore have the goal of contributing to the fundamental science of macromolecules, of furthering the progress of knowledge about certain essential properties of living matter, and of helping the development of the industrial production of high polymers. In this latter domain relations already exist between the Centre and various industrial establishments, the technologists of which are specializing in the various techniques needed for work on high polymers. Representatives from industries outside France will frequently discuss with the staff at the Centre problems concerned with the production of high polymers. The industry of the region will also be interested directly in the development of the Centre.

NEW INTERNATIONAL BAROMETER CONVENTIONS

By P. H. BIGG
National Physical Laboratory

THE purpose of this article is to bring to the notice of barometer users generally a new rationalized system of barometer conventions which has received strong support both in Great Britain and internationally, and will come into operation on January 1, 1955.

The development of the mercury barometer has been unfortunate in the number of scales which have come into use and in the variety of temperature and gravity values which have been associated with these scales. The use of three standard temperatures (0° C., 12° C. and 62° F.) with three variants of standard gravity (980·665 cm./s.², 980·62 cm./s.², and gravity at mean sea-level in lat. 45°), combined with the possibility of five scales (millibar, millimetre, inch, altitude in metres and altitude in feet), has been the cause of much misconception and error. The situation has been further complicated by the differing temperature coefficients of barometers with fiducial adjustment (for example, Fortin) and those without it (for example, Kew).

That much confusion and error were associated with the correlation and correction of readings on the various scales of these two types of barometer became increasingly evident to the National Physical Laboratory in the course of its barometric work; and hence, soon after the War, it initiated discussions with the Meteorological Office and the Ministry of Supply. At these discussions there was general agreement that simplification is most desirable. After consulting standards laboratories and meteorological organizations in the British Commonwealth and in the United States, and later the Comité International des Poids et Mesures, agreed proposals for the new system of conventions were submitted to the International Organization for Standardization (ISO) and the World Meteorological Organization (WMO). Committee ISO/TC12 of the International Organization for Standardization, which is concerned with quantities, units, symbols, conversion factors and conversion tables, at its meeting in October 1952 approved in principle the units associated with the new conventions and raised no objection to the adoption of the conventions as a whole. In 1953, the Executive of the World Meteorological Organization approved the proposals. The conventions have more recently been adopted by the British Standards Institution, and a British Standard* on the subject is in the course of publication.

The New Conventions

In the form adopted by the British Standards Institution, the rationalized conventions are as follows:

(1) *Pressure units.* Apart from the basic unit of pressure, namely, the dyne per square centimetre (symbol dyn/cm²), the following pressure units only shall be recognized for barometric purposes. They are given in order of preference, the millibar being strongly recommended.

(i) The millibar, equal to 1,000 dyn/cm² (symbol mb).

(ii) The millimetre of mercury at 0° C and standard gravity 980·665 cm/s² (symbol mmHg).

(iii) The inch of mercury at 0° C and standard gravity 980·665 cm/s² (symbol inHg).

By 'mercury at 0° C' is meant a hypothetical fluid having an invariable density exactly 13·5951 g/cm³. By 'inch' is meant a length of 25·4 millimetres exactly.

(2) *Standard instrumental conditions.*

(*a*) *Pressure scales.* Mercury barometers bearing scales representing the above units shall measure pressures directly in these units when the whole barometer is at 0° C and is subject to standard gravity 980·665 cm/s².

(*b*) *Altitude scales.* Mercury barometers bearing altitude scales shall correctly translate the applied pressure into the corresponding altitude (on the pressure/altitude relationship adopted) when the whole barometer is at 0° C and is subject to standard gravity 980·665 cm/s². (The definition of the various relationships between pressure and altitude in the atmosphere, and of the underlying assumptions, is not within the scope of the new barometer conventions, which are concerned with the conditions of use of barometers bearing scales complying with these relationships.)

The reforms which have been introduced arise mainly from the exclusive use of a single conventional value for standard gravity, together with a single reference temperature, in the definition of the millimetre and inch pressure units and in the

* British Standard 2520. Barometer Conventions and Tables. (British Standards Institution, British Standards House, 2 Park Street, London, W.1.)

standard instrumental conditions associated with all scales, including those of altitude.

The need for relating barometric measurements to a definite gravity value has long been recognized. In the past, various values have been used. The recent general acceptance of the conventional value for standard gravity, 980·665 cm./s.² (which is not now associated with lat. 45° and is therefore not liable to revision), and its adoption as the reference value for all barometric purposes, constitute notable steps forward. The similar use of a conventional value for the density of mercury at 0° C. is also a noteworthy advance, as it gives precision and permanence to the millimetre and inch pressure units, while not precluding allowance being made, in barometric measurements of extreme accuracy, for the actual density of the mercury at 0° C.

In the past, it has not been clear whether millimetre and inch scales on mercury barometers should be regarded as scales of pressure (as they are on aneroid barometers) or as scales of length set up to measure the length of the mercury column. The millibar scale has always been free from such doubt, the millibar being clearly a unit of pressure and not of length. It has now been decided to regard all three scales as pressure scales, giving readings in the standard pressure units when the barometer is under standard instrumental conditions.

Effect of the Changes

The adoption of the new conventions will greatly simplify the manufacture and standardization of mercury barometers, the correction of their readings to standard conditions, the final expression of pressures, and the conversion of either readings or pressures from one scale unit to another.

As aneroid barometers are also to be regarded as graduated in terms of the new pressure units, their readings will show the same inter-relationships as the scale readings on mercury barometers.

At a pressure of about 1,000 mb. the reading of a Fortin millibar barometer graduated on the new basis will be 2·0 mb. *greater* than one graduated on the old basis. This is almost entirely due to the change in the standard temperature of the mercury from 12° to 0° C., and the difference is proportional to pressure. Millimetre Fortin and Kew barometers will remain unaltered, because their scales have always been standardized at 0° C. At ordinary atmospheric pressures the reading of an inch Fortin barometer will be 0·01 *less* than before. This is due to the change in the length of the inch scale between 62° F. and 0° C. The difference is proportional to pressure. On account of the special temperature coefficients of Kew-type barometers, millibar and inch Kew barometers will not be affected in quite the same way as the corresponding Fortin barometers. Details will be found in B.S. 2520.

Implementation of the Changes

It is recommended that existing millibar and inch mercury barometers should be modified to comply with the new conventions as soon as is practicable, for example, when barometers are due for repair. As from January 1, 1955, the testing of barometers by the National Physical Laboratory will be based exclusively on the new conventions; new barometers will be required to satisfy the Laboratory tolerances. For the time being, barometers already in service will be admitted unaltered to the test provided that certain inscriptions required by the British Standard have been marked permanently upon them. To prevent misconception, a small label referring to the National Physical Laboratory test will be attached to any unaltered barometer which shows large index corrections as a result of the change in the basis of the pressure scale.

Save in exceptional circumstances, no accurate pressure measurements can be obtained with a mercury barometer unless due correction is made on account of temperature and gravity. The British tables hitherto used for this purpose have been derived for the most part from the International Meteorological Tables published in 1890 and not since revised. In relation to modern instruments and pressure units they have for many years been incomplete and, to some extent, inaccurate. The British Standard therefore incorporates comprehensive correction tables, applicable to all current types of mercury barometer, on the basis of the new units and conventions.

The advantages of the new system are permanent, and will far outweigh the inconveniences in first applying them. The conventions will be implemented in important government services and by the barometer manufacturers. It is hoped that scientific workers and others will henceforth express barometric pressures exclusively in terms of the international units and symbols, and, with the view of reducing to a minimum the period of change-over, that they will have their millibar and inch barometers brought into accord with the new conventions at the first opportunity.

I wish to acknowledge the responsibility of Mr. F. A. Gould, who was until lately in charge of the barometric work at the National Physical Laboratory, for the Laboratory's part in the development of the new conventions. This work was carried out as part of the research programme of the Laboratory, and the present paper is published by permission of the Director of the Laboratory.

OBITUARIES

Prof. R. E. D. Baker

Richard Eric Defoe Baker, professor of botany in the Imperial College of Tropical Agriculture, died in Trinidad on November 19, of heart failure after a short illness, in his forty-sixth year. His death is a great loss to botanical science in the tropics, and especially to the College which he served untiringly for more than twenty years.

Born in 1908, Baker was educated at Oundle and Trinity Hall, Cambridge, where he obtained a first class in Part II of the Natural Sciences Tripos; he also rowed for his College. After a year of postgraduate study at the Imperial College of Tropical Agriculture, of which he was awarded the associateship, in 1933 he was appointed lecturer in mycology in the College, and promoted to professor in 1945. Although his earlier interests were mainly in cryptogamic botany, in which he did outstanding work on witches' broom disease of cacao (*Marasmius perniciosus* Stahel), he was no narrow specialist, and in 1949 was appointed to the chair of the newly amalgamated Departments of Botany and Mycology. He was an enthusiastic student of the phanerogamic flora of Trinidad and since 1947 had been editor of the "Flora of Trinidad

and Tobago", of which most of the parts dealing with the Dicotyledons have already been published or are in the press. He was in charge of the botanical sections of the banana and cocoa research schemes at the College, and in 1948 he went on an expedition to East Africa to collect wild and cultivated species of bananas for extension of the breeding stocks. In 1952 he led an expedition to Colombia for the purpose of collecting wild species of *Theobroma*. He was also largely responsible for the successful organization of River Estate, the College's field station for cacao research.

Baker (or 'Dick', as he was known to staff and students alike) had a charming personality, a great sense of humour, and an interest in many subjects apart from his profession. Although, perhaps, he sometimes found it difficult to suffer fools gladly, he freely offered his time and experience to those whom he did not consider to be fools, and in this his judgment was seldom, if ever, at fault. The news of his untimely death will be a great shock to the numerous past students of the Imperial College of Tropical Agriculture, now scattered over all parts of the British Commonwealth, who have been taught and inspired by him.

If he was not, in the ordinary sense, a religious man, he whole-heartedly put into practice that great precept, "Whatsoever thy hand findest to do, do it with all thy might". He has been buried in the College cemetery, next to the grave of his former professor, H. R. Briton-Jones, who died in 1936. He is survived by a widow and four daughters.

T. W. KIRKPATRICK

Mr. H. G. Yates

BY the very sudden and untimely death on September 15 of Mr. Henry George Yates, the marine turbine industry has suffered a serious loss. At the age of forty-six he had not reached the peak of his activities, and his abilities as a steam turbine designer in the marine industry were widely recognized and appreciated. He was widely read, interested in amateur dramatics, and had a happy family life, although his two children are only at the start of their scholastic careers.

The study of vibration was a great hobby of his. Anything from the vibration of a sewing machine at home to the most complex types of vibration occurring in geared turbine systems was strenuously investigated. He had outstanding patience in explaining the more abstruse points in designs. His eyesight had been defective from birth in one eye, but he developed amazing ability in dealing with complex mathematical formulæ in his head.

After a distinguished scholastic career, he graduated at Trinity College, Dublin, in 1930 with first-class moderatorships in mathematics and physics and was afterwards awarded the M.A. degree. He continued at the University as a lecturer in physics for two years before deciding that he would prefer to be an engineer. He served a student apprenticeship with the English Electric Co., Ltd., at its Willans Works, Rugby, and was employed after his apprenticeship in the Turbine Department of the Company. In 1940 a Research Department was set up, and Yates was put in charge of the work. He joined the Parsons and Marine Engineering Turbine Research and Development Association (Pametrada) very near the beginning, and was associated with the growth of the Association, particularly in the work of the Design Department, in which many designs were prepared for turbine machinery to be installed in important British and foreign ships, the total horse-power of the designs aggregating some seven million. During this time Pametrada acquired a number of foreign licences, which enabled Yates's work to influence building in countries such as Holland and Canada.

Yates was an associate member of the Institution of Mechanical Engineers, Fellow of the Institute of Physics, a member of the American Society of Mechanical Engineers, and at the time of his death was a member of council of the North-East Coast Institution of Engineers and Shipbuilders and chairman of the North-East Branch of the Institute of Physics. Apart from the technical committees of Pametrada on which he was a valued member, he was on the Admiralty Noise Reduction Panel NRP.2, AVGRA Sub-Committee *D*, the Admiralty Gearing Noise Advisory Panel, the Heat Transfer and Heat Exchange Committee of the Mechanical Engineering Research Organization and Committee *J* (Power Plant) of the British Electrical and Allied Industries Research Association.

The thing that struck most people meeting him for the first time was his great personal charm and very quiet way in explaining difficult points in design so that they became clear and easy to understand. He is greatly mourned by his colleagues at Pametrada, where he spent the last ten years of his life in charge of the Design Department.

THOMAS W. F. BROWN

Mr. E. Laurmann

THE sudden death of Emil Laurmann on November 10 at the age of sixty-four came as a great shock to his friends and colleagues in the Royal Society Mond Laboratory, Cambridge. An Estonian by birth, he was trained as an engineer at Strelitz in Germany but was unable to complete the course owing to the outbreak of war in 1914; he worked for a time at Siemens in Leningrad, and then at the newly organized Polytechnic Institute, where he started his collaboration with Kapitza. In 1922 he followed Kapitza to Cambridge and for many years acted as his personal assistant, first in the magnetic department of the Cavendish Laboratory and later in the Mond Laboratory. His qualities of inventiveness, skill and patience in all sorts of techniques such as electrical engineering, fine mechanics, photography and the handling of delicate metal crystals, contributed largely to the successful outcome of Kapitza's investigations at very high magnetic fields. After Kapitza's return to the Soviet Union, Laurmann spent a year in Moscow helping to set up similar equipment at the Institute for Physical Problems and collaborated with Kapitza in studies of the Zeeman effect at very high fields.

During the years since the Second World War, Laurmann worked with me in various researches on superconductivity and the magnetic behaviour of metals at low temperatures, and I owe more than I can adequately express in words not only to his technical skill and ingenuity but also to his patience and good nature. Many others in the Mond Laboratory have also benefited from his advice and help, which he always gave willingly in a characteristically quiet and unassuming way; his presence in the Laboratory will be sadly missed. He is survived by his widow, a daughter and a son. D. SHOENBERG

NEWS and VIEWS

Imperial College of Science and Technology: Appointment of Rector

Prof. R. P. Linstead, professor of organic chemistry in the Imperial College of Science and Technology, London, has been appointed rector of the College in succession to the late Sir Roderic Hill. Prof. Linstead had been director of the Chemical Research Laboratory (Department of Scientific and Industrial Research) before he went to his present post in the Imperial College in 1949 (see *Nature*, **163**, 558; 1949).

Paris: New Scientific Attaché

Mr. A. C. Copisarow has been appointed scientific attaché to the British Embassy in Paris. Mr. Copisarow graduated in the honours school of geology of the University of Manchester in 1942, specializing in mineralogy and petrology. He served for four years in the Royal Navy, and was a member of the Ultra-Short-Wave Panel of the Scientific Advisory Council. Entering the Civil Service in 1947, Mr. Copisarow eventually became head of the Industrial Sub-Division in the Ministry of Defence. His published work includes a number of experimental papers on the colloidal chemistry of silica.

Sheep Biology Laboratory, Prospect, New South Wales: Dr. I. W. McDonald

Dr. I. W. McDonald has been appointed officer-in-charge of the Sheep Biology Laboratory, Prospect, New South Wales, of the Commonwealth Scientific and Industrial Research Organization, Australia, in succession to Prof. C. W. Emmens, professor of veterinary physiology in the University of Sydney, who has been acting as officer-in-charge since 1952 (see *Nature*, **170**, 954 (1952), and also **171**, 597 (1953)). Dr. McDonald is a former student of Hawkesbury Agricultural College and a graduate of the University of Sydney. After graduation he undertook research on the nutrition of sheep at the Animal Nutrition Laboratory of the Commonwealth Scientific and Industrial Research Organization and at the Institute of Medical and Veterinary Science, Adelaide, where he was appointed deputy director. In 1945 he went to the Universities of Cambridge and Sheffield, gaining a Ph.D. for studies in the metabolism of the sheep, with special reference to the digestion of protein, and since 1948 he has been a senior principal scientific officer at the Institute of Animal Physiology, Cambridge, where he has continued his researches on the processes of digestion in the sheep.

The Australian Museum, Sydney: Dr. J. W. Evans

Dr. J. W. Evans, deputy chief scientific officer of the Civil Service in Great Britain, has been appointed director of the Australian Museum, Sydney, in succession to Dr. A. B. Walkom. After graduating at Cambridge, Dr. Evans went to Australia in 1926 and joined the staff of the Council for Scientific and Industrial Research. He held various appointments in Australia and returned to London in 1944. He has had wide scientific and administrative experience. Though employed chiefly as an applied entomologist, his forty to fifty papers indicate wider interests in taxonomy, comparative morphology and ecology.

Scientific Work on Smokeless Fuels

In a Royal Institution Discourse on December 10, Sir Charles Ellis described the National Coal Board's research work into the production of high-class solid smokeless fuels. The problem, he said, is twofold: it is necessary to remove the volatile matter from coal in some way that pays for itself; and secondly, coal used must not be carbonization type, the long-term supply position of which is giving cause for considerable anxiety in Britain. The National Coal Board, he said, intends to develop a range of smokeless fuels that will be specialized to their individual purposes and will be premium fuels. In spite of the urgency of the situation, the Board believes that a long-term policy is necessary, and it is aiming at developing new processes that will represent a real technological advance.

One promising line of work starts with 'fines', or powdered coal. This is subjected to a fluidization process, in which a column of hot gas or steam is blown upwards through the fine coal in a heated vertical chamber; this results in chemical changes in the coal and the separation of the volatile substances and oils. The product of this process is difficult to make into briquettes, so a binder such as pitch is added; this involves a further process of carbonization. For this purpose the hot-sand carbonization process has proved to be of great importance. It gives rapid carbonization; also, it is a continuous process. A small plant working on a 50 lb. an hour scale has been completed and the possibility of the process established. A drawback of compressing the less suitable types of coal into briquettes is that a binder has to be used. Quite recently, Sir Charles said, it has been found at the National Coal Board's research establishment that these high volatile coals can be made to stick together without using any binder. This discovery may revolutionize our thinking on the whole subject of supplies to consumers.

Scientific Research and Industrial Productivity

In No. 7 (July 1954) of the "Occasional Bulletin" from Sondes Place Research Institute, Dorking, which resumes publication after two and a half years, the problem of research and productivity is discussed with reference to the more effective use by industry of applied science to improve its technological efficiency. It is recognized that labour productivity is not the only factor affecting the overall efficiency, nor necessarily the most important, and that productivity depends upon many factors other than economic, such as technical efficiency, the extent to which manual labour is lightened by the use of machines, enlightened and efficient management, good relations with trade unions, the existence of adequate incentives, taxation policy and the nature of the social system. Higher productive efficiency can never be achieved if any one of these factors is ignored; but, limiting itself to technological efficiency, the Bulletin argues that a more intensive application of scientific methods to industrial problems offers great potentialities for increased productive efficiency. Pointing out that 98 per cent of Britain's factories employ less than two hundred and fifty workers but that more than 50 per cent of the country's industrial workers are employed in such factories, the Bulletin comments that, if the survey recently conducted by the Manchester Joint Research Council is representative of conditions elsewhere, up to half of the population of Great Britain is employed in industries where the chances of greater productivity arising from technological advances are remote. For such small firms the independent research institute is particularly useful, and the

Sondes Research Institute has always endeavoured to supply the research tools and the trained staff which such firms lack. All rights in any discoveries made in a project are automatically assigned to the sponsor, so that the Institute may be regarded as the research department of the sponsor for the duration of the project. Experience at Sondes Place confirms the difficulty of liaison with industrialists who are unable to define their own problems in terms which the technical man can understand, and also the backwardness of small firms in appreciating the contribution science can make to improving productivity.

Technical Graduates in the British Armed Services

In written answers to Parliamentary questions on November 22, the Minister of Defence, Mr. H. Macmillan, stated that about 940 uniformed personnel at present employed on instructional duties in the Fighting Services hold degrees in science, including mathematics and engineering, the average annual intake for this purpose into the Royal Navy and the Royal Air Force together during the past three years being about 165. In addition, some 120 civilian science or engineering graduates are employed on instructional duties with all three Services, with an average annual intake of about ten during the past three years. Some 2,860 civilian science and engineering graduates are employed on research and development by the Service and supply departments, the average annual intake during the past three years being about 185. Science graduates are not recruited into the Services specifically for research and development duties, but about 110 uniformed personnel holding degrees in science, including mathematics and engineering, are in addition employed on research and development for the Services.

J. A. Gilruth and his Influence on Commonwealth Livestock Industries

This year the Macrossan Memorial Lecture was given at the University of Queensland by Sir Ian Clunies-Ross, chairman of the Commonwealth Scientific and Industrial Research Organization, Australia, who chose as his subject "John Anderson Gilruth: the Influence of his Life and Work on the Development of the Livestock Industries of the Commonwealth". Gilruth combined a forceful personality with true administrative and scientific ability. After training as a veterinarian at Glasgow, he spent seventeen years in New Zealand, where he built up what was probably the best government veterinary service in the British Commonwealth. Sir Ian considers this service one of the chief reasons why New Zealand achieved such a high reputation for exports of lamb and dairy produce. In 1909 Gilruth was appointed the first professor of veterinary science in the University of Melbourne, where he established the first five-year veterinary course in the British Commonwealth, if not in the world. The last and equally fruitful phase of his career started in 1929, when he was appointed chief of the Division of Animal Health of the then newly formed Council for Scientific and Industrial Research, now the Commonwealth Scientific and Industrial Research Organization. His sound judgment and planning have been reflected in the output of important research by the Organization in nutrition and infectious diseases, much of it fundamental in nature. His strong personality and original mind were responsible for the initiation and successful pursuance of a number of investigations that have yielded far-reaching results. Sir Ian then reviewed the achievements of Australian scientific workers in these fields and closed by pointing to some major problems still confronting the further development of Australia's agricultural industry—problems that offer a fascinating challenge to the best scientists that the country can produce.

Indian Journal of Fisheries

The first issue of a new journal, the *Indian Journal of Fisheries* (1, Nos. 1 and 2; May 1954; pp. 416+8 plates; Rs. 7.8 net), published by the Ministry of Food and Agriculture of the Government of India, New Delhi, has recently appeared, and the welcome that one would normally accord to a new periodical devoted to scientific research in India is all the warmer for one that deals with questions likely to increase food supplies. The journal deals with fisheries research in Indian and adjacent waters—freshwater, lacustrine and salt water—and there are papers on plankton, algae, molluscs, crustaceans and fish. In all cases attention is given to the practical aspect of ensuring a continuation and improvement of the fish supply, the spawning and growth of fish being carefully considered. A detailed description is given of the Central Marine Fisheries Station, Mandapam Camp, Southern India, and this account must arouse envy in the hearts of fishery research workers in Europe, for there are twenty-three scientific officers, twenty-two research assistants and fourteen fishery survey assistants, in addition to the normal administrative staff. There are also subsidiary research stations, notably in Calicut and Karwar, and an inland fisheries research station has been established in Calcutta. There are lists of the publications issued at Mandapam and Calcutta. The Government of India is to be heartily congratulated, since in this issue of the new journal practically no problem connected with the fisheries is overlooked or neglected.

Fisheries of Lake Chilka in Southern India

Chilka Lake, which is situated on the east coast of India near Puri in the State of Orissa, is really a lagoon, for it communicates with the open sea by a narrow channel fourteen miles long. In the rainy season the area is 450 square miles, shrinking to 350 square miles in dry weather. It is very shallow, varying in the dry season from 8 to 4 ft. in depth. The salinity varies from practically fresh water to a high salinity near the sea entrance. Consequently, there is a remarkable fauna, both of fish and invertebrates. The total number of species of fish known in the Lake is 138. Large quantities of carp fry drift down into the Lake during floods and are utilized for stocking freshwater tanks. The shallowness of the Lake makes fishing comparatively easy, and the bulk of the catches goes by rail to Calcutta. A full description of the methods of fishing is given in the paper by S. Jones and K. H. Sujansingani in the first volume of the new *Indian Journal of Fisheries* (see above). The chief food fish are mullets, clupeoids, catfishes, sciosnoids, perches and bekti, and the yield per acre (both fresh and dried fish) amounted in the years 1948, 1949 and 1950 to 34·48, 31·58 and 29·80 lb., respectively. Since the Lake is an uncultivated piece of water and more than a fourth of it is too shallow to support a good fishery, these totals must be considered satisfactory. The authors recommend the abolition of the present zemindari (landlord) system and the transfer of the fishing rights to the State.

Methods of preserving the future supply are carefully considered, and a minimum size limit for fishes of economic importance during certain seasons is recommended. The crab fishery of the Lake has also been dealt with by the same authors (*J. Bombay Nat. Hist. Soc.*, 1952), and great credit is due to them for these two valuable reports.

Scientific Observations on Heard Island in the Antarctic

The Southern Ocean—the ocean surrounding the Antarctic Continent—is divided into two main hydrological zones by the Antarctic Convergence, the line of demarcation at the surface of the ocean between the cold antarctic water and the warmer subantarctic water. The Ocean contains several isolated islands and groups of islands, including the following: South Georgia, South Sandwich Islands, Bouvetoya, Prince Edward Islands, Iles Crozet, Iles de Kerguelen, Heard Island, Macquarie Island, Campbell Island and Auckland Island. Differences in their altitudes, atmospheric circulation and ocean currents, combined with their positions relative to the Antarctic Convergence, have resulted in some of these islands being ice-covered and glaciated whereas others are clothed in grass and other non-arboreal vegetation. Heard Island (lat. 53° S., long. 73½° E.), which lies about nine hundred miles north of the western sector of Australian Antarctic Territory, is a typical ice-capped antarctic island. The recent establishment of a research station by the Commonwealth of Australia on Heard Island makes it possible to provide the first comprehensive scientific information on the geography, geology, meteorology, flora and fauna of the Island. This report has been prepared by P. G. Law and T. Burstall and issued by the Antarctic Division, Department of External Affairs, 187 Collins Street, Melbourne (Interim Report No. 7; pp. 32+7 plates; 1953). It also contains accounts of recordings to extend studies in geomagnetism, seismology and knowledge of cosmic rays, as well as observations of the aurora australis.

University of Birmingham

The following have been appointed lecturers in the University of Birmingham: E. H. Wright (mechanical engineering), Dr. S. A. Barker (chemistry), Dr. K. F. Chackett (physics), C. B. Wright (physical metallurgy), Dr. J. D. Blainey (experimental pathology), J. B. W. Halley and K. R. Thornton (pathology), and Dr. N. S. Ross (Harry Payne lecturer in employer–employee relations). The following have been appointed to research fellowships: Dr. Jacques Vilain, Dr. P. D. Whitaker and E. A. Finlay (physics); Dr. O. Theander, Dr. A. Sykes, Dr. C. R. Patrick and M. Kapel (chemistry); Dr. E. L. Breese and Dr. F. W. Allard (genetics); J. R. Coope (geology); Dr. A. D. Hudson, Dr. Francine Gregoire and Dr. A. L. Woolf (pathology); Dr. P. B. Bradley (experimental psychiatry); and W. A. Coppel (pure mathematics). The following have resigned from the University: Dr. Hilde Behrend, research fellow in commerce, and J. S. Howell, research fellow in pathology. The National Coal Board has provided a sum of £1,600 for research in the Department of Mining of the University, and Unilever, Ltd., has made a grant to the Institute of Engineering Production of £200 a year for seven years towards expenses of the Institute. In the Department of Chemistry, 15,000 dollars has been provided by the Rockefeller Foundation for Prof. M. Stacey's research in biochemistry, the amount to be spent over three years, and the Geigy Company has sponsored a research fellowship in the field of organic chemistry for one year.

Announcements

Prof. R. E. Glover, professor of veterinary pathology in the University of Liverpool since 1949, and a past president of the Royal College of Veterinary Surgeons, has been appointed principal and dean of the Royal Veterinary College in succession to the late Prof. J. B. Buxton.

The Minister of Agriculture and Fisheries and the Secretary of State for Scotland have appointed Lord St. Aldwyn, joint parliamentary secretary to the Ministry of Agriculture and Fisheries, as chairman of the Myxomatosis Advisory Committee in succession to Lord Carrington. Dr. I. Thomas, deputy chief scientific officer to the Ministry of Agriculture and Fisheries, has been appointed a member of the Committee in succession to Dr. J. W. Evans (see p. 1130).

Lieut.-Colonel L. F. Urwick has been awarded the Wallace Clark International Management Award for 1955. This Award has been given annually since 1948 by the American Society of Mechanical Engineers, the American Management Association, the Society for the Advancement of Management and the Association of Consulting Management Engineers, and is presented by the Council for International Progress in Management (U.S.A.), which represents the American management movement internationally. Colonel Urwick is the first British national to receive the Award.

Under the will of the late Francis Amory, the American Academy of Arts and Sciences is offering a substantial prize for outstanding work on some aspect of the alleviation or cure of diseases affecting the human reproductive organs, in particular those of men. Nominations, supported by statements of qualifications with regard to work done since 1947, should be sent as soon as possible to the American Academy of Arts and Sciences, 28 Newbury Street, Boston 16, Massachusetts.

The Institution of Naval Architects is offering the following scholarships for training in a university institution: *I.N.A.–Elgar–Martell Scholarship*, for naval architecture, worth £275 a year, which is open to British subjects less than twenty-three years old who have been employed for at least two years upon shipbuilding (entries close January 14, 1955); *Denny Scholarships*, one in naval architecture and one in marine engineering, worth £175 a year for four years at the University of Glasgow, with apprenticeship of five years, which is open to British subjects less than nineteen years old (entries close May 31, 1955). Further information can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

A telegram has been received from Copenhagen announcing the discovery by Abell, at Palomar, of an asteroid on December 3. Its position was R.A. 7h. 08·1m., Dec. −21° 19′; daily motion: in R.A. −06m. 46s.; in Dec. −01·25°; mag. 17; appearance stellar.

Erratum. In the article on "Chemistry of some Natural Pigments" in *Nature* of November 27, p. 990, col. 2, eight lines from the bottom, for ". . . introduced into tetramethyl tetrazaporphin . . ." read ". . . introduced into octamethyl tetrazaporphin . . .".

ROCKEFELLER FOUNDATION GRANTS

GRANTS made by the Rockefeller Foundation during the third quarter of this year totalled 1,015,696 dollars. During the same period, the Foundation awarded thirty-nine fellowships to individuals from twenty countries. Among the grants to institutions are the following: £24,000 and 10,000 dollars (about 82,000 dollars in all) to the Royal Technical College, Glasgow, for post-graduate training and research in environmental control engineering, to be conducted with the several new towns in the Scottish Highlands in mind, which are now in varying stages of development; 50,000 dollars to the Department of Biochemistry of the Pasteur Institute, Paris, for the purchase of research equipment and other purposes; 45,000 dollars over five years to the Department of Chemistry, University of Edinburgh, for research on natural high polymers; 12,000,000 lire (about 22,000 dollars) over a period of three years to the Institute of Zoology, University of Pavia, for cytogenetic studies of mosquitoes; 30,000 dollars to the Marine Biological Association of the United Kingdom for use at its laboratory in Plymouth; 30,000 dollars to the Strangeways Research Laboratory, Cambridge, for the purchase of an electron microscope; 30,000 dollars over three years to the biophysical research unit at King's College, London; 30,000 dollars over three years to the Gordon Research Conferences of the American Association for the Advancement of Science, as a continuation of previous aid for financing the visits of selected foreign scientists to the United States to attend conferences on the chemistry of biologically significant molecules; 15,000 dollars over two years to the Royal Institution of Great Britain and its associated Davy Faraday Research Laboratory towards the expenses of research on the structure of proteins; 15,000 dollars over three years to the University of Birmingham for further support of the research in the chemistry of carbohydrates under the direction of Prof. M. Stacey.

Other grants made in the third quarter of this year include the following: 500 dollars to Dr. George Otto Gey, director of the Division for Cellular Pathology, Department of Surgery, Johns Hopkins University, Baltimore, to visit European laboratories conducting work in cell research and virology; 10,000 dollars to the Inter-American Society of Soils Scientists for meetings of the Society during the period ending March 31, 1956; 5,000 dollars to the University of Arizona, Tucson, for a conference on the problem of cloud physics research held in Tucson during August 1954; 3,500 dollars to McGill University, Montreal, for aid to the general organizing committee in preparation for the Tenth International Congress of Genetics to be held at McGill in 1958; 1,000 dollars to the University of Liège for research in carbohydrate chemistry, under the direction of Dr. Claude Liébecq, of the Institute of Higher Physical Education; 2,200 dollars to the University of Paris, for research in chemical genetics, under the direction of Prof. Boris Ephrussi; 6,000 dollars to the Institute of Anatomy, Karolinska Institute, Stockholm, as a further contribution towards the purchase of an electron microscope to be used for research under the direction of Dr. Fritiof S. Sjöstrand; 5,000 dollars to the Institute of Physiology, University of Geneva, for the purchase of equipment to be used by Prof. Jean Posternak; 7,500 dollars to the University of Glasgow for three small working conferences of European scientists interested in genetical problems, to be held during the five-year period beginning January 1, 1955; 7,200 dollars to the Department of Biological Chemistry, University of Aberdeen, for equipment to be used in general biochemical research; 2,000 dollars to the Department of Natural History, University of St. Andrews, for equipment for research in marine biology; 895 dollars to the Virus Research Institute, Lagos, for air-conditioning equipment; 5,500 dollars to the Department of Physiology, Medical College, Indore, for equipment to be used under the direction of Dr. J. C. Sachdev; 2,000 dollars to the Department of Microbiology, Institute of Public Health, Tokyo, for the application of tissue culture methods to the study of viruses; 2,000 dollars to Dr. Konoshin Onodera, of Kyoto University, to visit the United States for research in carbohydrate chemistry at Ohio State University, Columbus; 3,000 dollars to Prof. Juan Sanchez Salcedo, jun., professor of chemical hygiene and nutrition, Institute of Hygiene, and professor of biochemistry, School of Medicine, University of the Philippines, Quezon City, to observe new developments in biochemistry and nutrition in Europe and the United States; 5,000 dollars to the Department of Biochemistry, University of Minas Gerais, Belo Horizonte, for equipment to be used by Dr. James B. Sumner; 39,200 cruzeiros (about 1,000 dollars) to the University of Rio Grande do Sul, Pôrto Alegre, towards the establishment of Casimiro Tondo as director of the Institute of Biophysics Research; 525 dollars to the Instituto Agronómico do Sul, State of Rio Grande do Sul, for equipment for investigations in soil physics; 3,350 dollars to Raul Cortes, entomologist in the Department of Agricultural Investigations, Ministry of Agriculture, Santiago, for visits to agricultural research centres in entomology in Latin America and the United States; 1,200 dollars to Joaquin Loredo, head of the Federal Extension Service, Ministry of Agriculture and Animal Industry, Mexico, to visit the United States Department of Agriculture and various State extension service centres; 975 dollars to Raul Palacios, representative of the Ministry of Agriculture and Animal Industry, Agricultural Directive Committee, State of Jalisco, Guadalajara, to visit agricultural research centres in the United States; and 7,300 dollars to the Faculty of Veterinary Medicine, University of San Marcos, Lima, for a co-operative project with the Ministry of Agriculture on the study of diseases of the alpaca, under the direction of Dr. Manuel Moro.

The 39 fellowships awarded by the Foundation during the third quarter of 1954 were distributed among the divisions as follows: medicine and public health, 15; natural sciences and agriculture, 10; social sciences, 7; and humanities, 7.

NATIONAL TRUST

ANNUAL REPORT

THE fifty-ninth annual report of the National Trust, presented to the annual general meeting on November 12, records an increase of 8,550 in membership during 1953, and the membership rose further from 44,450 to 47,676 by July 1, 1954, in spite of the increase in minimum subscription for new members from 10*s.* to £1. For the year ending December 31, 1953, the deficit on ordinary maintenance and administration was about £1,500 compared with deficits of £33,000 and £29,000 for 1951 and 1952, respectively. The position, however, is less encouraging than these figures suggest. The Trust has both a general fund and numerous special funds which can be used only in connexion with particular properties. When such properties show surpluses of income over expenditure, these surpluses are not available to the general funds of the Trust but must be credited to the special trusts concerned, and surpluses of £14,000 were so credited in 1953. On the other hand, deficits on special trust properties have to be met by loans (totalling £15,000 in 1953) from general funds; and taking into account also a similar position which arises with certain properties managed by local committees, the general funds have been called upon to contribute not £1,500 but £22,500 to meet the deficit on ordinary maintenance and administration. It is thus obvious that the natural pull towards the special funds may seriously embarrass the smooth working of the Trust, and the report emphasizes the paramount importance of more 'free' money that can be spent on the general purposes of the Trust and is not tied to one particular property.

The fall in timber prices has also seriously affected the Trust's income, but the Council expresses the hope that the Trust's woodlands will be self-supporting, that in future the property income and membership subscriptions will more than cover the costs of maintenance and administration, that free gifts and bequests will be available to finance improvements, and that the funds for specific purposes will, whenever possible, be used for the purchase or endowment of new properties. Concern is expressed in the report at the inadequate protection afforded to scenery of natural beauty in certain areas by the Town and Country Planning Acts, and it is pointed out that Trust ownership, or covenants with the Trust, still offers valuable protection for unspoilt countryside and, in particular, for stretches of coastal scenery where the pressure for development is usually most vocal and powerful. The Council, while recognizing the necessity for a new orbital road south of London, has strongly opposed the Surrey County Council's choice of route, which is planned to traverse the North Downs, cutting across commons and stretches of country of exceptional beauty, either in the Metropolitan Green Belt or proposed as a conservation area in the National Parks report.

During the year, the General and Specific Purposes Funds have been supplemented by three grants under the Historic Buildings and Ancient Monuments Act, 1953, of £2,100 for repairs to the Treasurer's House, York; £9,000 for repairs to Dunsland House, Devon; and £3,000 for repairs and £1,000 a year for four years for the maintenance of Lyme Park, Cheshire. But at the annual meeting of the Trust, Sir Alan Lascelles, chairman of the Historic Buildings Council for England, said that, while the prospect for historic buildings other than houses is reasonably satisfactory, the outlook for houses generally is sombre. The threat is social rather than financial. Many historic houses owe their preservation solely to the devoted work of their occupants; as that older generation dies out, private maintenance inevitably becomes rarer and public maintenance more and more necessary if such buildings and their contents are to survive. Lord Crawford and Balcarres, presiding over the meeting, referred also to the unnecessary destruction which is taking place and to the damage caused, for example, by the careless siting of electricity generating stations.

CIVIL ENGINEERING TO-DAY

PRESIDENTIAL ADDRESS TO THE INSTITUTION OF CIVIL ENGINEERS

IN his presidential address to the Institution of Civil Engineers, given on November 2, Mr. David Watson directed attention to the wide sphere of interest of the Institution, at its inception in 1818 and during its early years. He quoted the remarks made by Sir John Rennie in 1845, on assuming office, who mentioned harbour construction, railway development, the manufacture of steam ships, drainage schemes, gas illumination, machinery manufacture and mining, as being among the interests of members of the Institution. Many of these pursuits are now the concern of other institutions, that of the civil engineers being concerned to-day almost exclusively with large-scale constructional work. This narrowing of scope is partly a natural process, though it may have been due to a philosophy which appears to have been based upon faith in past experience, rather than in the possibilities of scientific research; but as Mr. Watson pointed out, the Institution remains available to all practising engineers whatever their speciality.

Although Sir John Rennie spoke in 1845 of the "deservedly high place our profession holds in public estimation", Mr. Watson doubts if the public of to-day is given the opportunity of forming an estimate of the place held by the civil engineer, who is too often content to be just a 'back-room boy', of whom the public has never heard. His work is taken for granted; he is too modest and does not seek recognition of the essential part he plays in inspiring, planning and working out all the practical details which eventually give place to the actual direction of the great sources of power in Nature to the use and convenience of man. The public does not know the heavy responsibility that rests on the engineer in spending public money on capital works; it does not realize that his lengthy processes of comparing many ways of doing even a simple job, assessing the life as well as the annual costs, is by no means a mechanical process. It is his experience and judgment which prompt him to recommend only one of the many schemes he has considered. Thereby he assumes the real, if not the nominal, responsibility.

Mr. Watson's own engineering activities have been mainly in the field of public health and sanitary engineering: it was his firm that was responsible for the West Middlesex main drainage scheme with its magnificent sewage disposal works at Mogden. This scheme, since its completion in the mid-thirties, has been an outstanding success and has encouraged the

development of biological methods of sewage purification. Such methods are eminently satisfactory for normal domestic wastes, but the biological action may be inhibited by large quantities of industrial waste or even by an excessive concentration of domestic detergents. Mr. Watson suggested that new legislation is long overdue to prevent the penalization of local authorities, owing to these novel and sometimes unpredictable hazards.

BACTERIOLOGY OF MILK AND MILK PRODUCTS

THE autumn meeting of the Society for Applied Bacteriology was held in London on October 26, when recent advances in the bacteriology of milk and milk products were discussed. Dr. J. G. Davis (London) was in the chair. The full papers of the symposium will appear in the *Journal of Applied Bacteriology* (**18**, No. 2).

W. A. Cuthbert (Leeds), introducing his paper on coli-aerogenes bacteria in dairy water supplies, explained that it was a continuation of an investigation, the earlier part of which had already been reported. Discussing sampling methods in farms and dairies, he directed attention to difficulties and dangers due to fire risks often encountered when carrying out the prescribed flaming of taps in farm buildings. A long series of tests has shown that there is no significant difference in coliform contents of samples taken with and without flaming.

Comparative tests made between brilliant green-bile broth and standard MacConkey broth for detecting *Bact. coli* showed that there is little to choose between the two methods, and hence there was no reason for changing from MacConkey's medium. It did not appear essential to limit the initial incubation period in MacConkey broth to twenty-four hours, as the percentage of positive responses obtained with longer incubation periods, either at 37° or 24° C., did not alter significantly. Incubation of the 44° confirmatory tests, however, could not be reduced to less than forty-eight hours, as there was a 7 per cent increase in positive responses during the second twenty-four hour period. Mr. Cuthbert said that the presence of true *Bact. coli* is generally accepted as an indication of recent fæcal pollution. He also showed that there is an association between the numbers of *Bact. coli* type I, total coli-aerogenes bacteria and fæcal streptococci found. Moreover, except for certain seasonal variations, the 44° and 37° counts vary together. On this basis he doubted whether the 44° confirmatory tests can be justified. There is a natural die-out of *Bact. coli* which varies with temperature and with *p*H of the water. For example, in water from limestone areas *Bact. coli* persists for forty-five days or more, whereas in acid peat soils it dies out in ten days or less.

A review was given by S. B. Thomas (Aberystwyth) of the incidence and classification of coli-aerogenes bacteria isolated at 37° and 30° from farm milk supplies during the past twenty years, in his paper on coli-aerogenes bacteria in milk. The five thousand strains isolated at 37° by fourteen investigators were about equally divided among *Bact. coli*, intermediate and aerogenes-cloacæ types. On the other hand, aerogenes-cloacæ types constituted about 50 per cent of the strains isolated at 30° at Aberystwyth. Only 15 per cent of the strains isolated at 30° from raw milk were 37° negative; the proportions were much higher with strains from soil, water, cereals and ungrazed herbage. It was shown that the coli-aerogenes content of farm milk supplies handled in sterilized equipment did not increase appreciably in 24 hr. at 10°–12°, whereas there was a very marked increase in milk produced under unsatisfactory conditions. Under clean conditions, these organisms were generally not detectable in 0·01 ml. even 24–28 hr. after milking. Mr. Thomas considered selective plating media superior to MacConkey's broth for the determination of the coli-aerogenes organisms content of milk, and said that there is an association between the *Bact. coli* and total coli-aerogenes organisms. On this basis, he maintained that the coli-aerogenes colony count at 30° provides valuable information for advisory work when applied to farm milk supplies within 6 hr. of production. The presence of coli-aerogenes bacteria in apparently normal udders was discussed in relation to the increasing use of penicillin in mastitis control.

The laboratory and field evaluation of chemical sterilizers for dairy farms was discussed by Dr. L. F. L. Clegg (Shinfield). He reviewed the different types of tests devised in past years, and divided them into two groups: 'suspension tests', in which the organisms in aqueous suspension are treated with the disinfectant dilutions; and 'surface tests', in which organisms on various surfaces are treated. From the aspect of practical application, particularly when the highly surface-active quaternary ammonium compounds are being considered, surface film tests are the most suitable, and at the National Institute for Research in Dairying three tests are being developed and undertaken: the laboratory Hoy can test and a surface film test, and finally farm trials. Details of the Hoy can test have been described elsewhere; in principle, the procedure consists of treating infected milk cans for a short period with test disinfectant dilutions, and then examining the effect of the rinse on the keeping quality of normal milk at 22°. This type of test is essentially a comparative one, and a hypochlorite–soda ash solution is used as the standard. In the surface film test, metal strips are inoculated with bacteria, treated for short periods with disinfectant solutions and the surviving bacteria enumerated. The effect of detergency can also be measured by agitating the test solutions gently during the disinfecting period. Experience has shown that dry films are disinfected more slowly than are moist ones, and the rate of disinfection is increased by agitation. Results generally are at a lower level than with suspension tests. For the final farm trials, it is essential to have a control disinfectant running at the same time as the test material, and the efficiency of disinfection is assessed by a combination of colony counts, methylene blue tests, and keeping-quality tests on the milks. In evaluating a new preparation it is important to examine not only its disinfectant properties, but also its effect on rubber and other equipment, and its influence on odour and taste of the milk.

J. D. Ridgway (Stockport) discussed some recent observations on the bacteriology of sterilized milk, and said that faults are generally due to sweet curdling and are more numerous on storage at 23° than 37°. There is an unexpectedly high proportion of failures in winter milks, and this is always due to sporing bacteria which had escaped destruction during the normal sterilization process of heating to 106·5° for 35 min. There is a linear relationship

between the logarithm of spore content and the number of samples failing, but there is no relationship between total bacterial content, the thermoduric bacterial content and the spore content of raw milks. Therefore, it is not possible to assess the value of milk for sterilization purposes in terms of good and bad farm milk-production; a good raw milk, or one which pasteurizes satisfactorily, may not give a sterilized milk which will keep well. The source of the spore-forming organisms has not been ascertained with certainty, but they do not appear to be air-borne. Spores have been found in udder milk, presumably originating from straw bedding used. The hygiene of plant is of utmost importance, and steam sterilization is only effective if the plant has been thoroughly pre-cleaned.

The value of the antibiotic nisin in cheese manufacture was described by H. B. Hawley (Yeovil) in a paper on the development and uses of nisin. He described how certain strains of *Strep. lactis* have been found to inhibit lactobacilli under given conditions, and investigations at the National Institute for Research in Dairying led to the discovery of nisin, which is produced by certain strains of the streptococcus. Nisin has a polypeptide structure, and there are several different known types. They have different antibacterial properties, and the types and proportions of each produced depend on the cultural conditions. Because of the particular value of nisin in inhibiting growth of *Cl. welchii*, it has been used effectively in the controlling of cheese, and is particularly valuable with processed cheeses; experimental work is proceeding at present on sweet, low-acid cheeses. Nisin can also be used for control of flat-sour in canning and in the preservation of other foods, particularly meat products. There are numerous and unexpected problems associated with the use of nisin in cheeses because, for example, it upsets the general balance of the bacterial flora and so may produce a cheese of very different texture, odour and taste. Moreover, the presence of certain bacteria appears to nullify the effect of the nisin.

CHARACTERISTICS OF THE BOTTOM ZONE OF LAKES

A SYMPOSIUM on "The Biological, Physical and Chemical Characteristics of the Profundal Zone of Lakes", organized by Prof. V. Tonolli, was held at the Istituto Italiano di Idrobiologia at Pallanza, Lago Maggiore, during July 21–24, under the auspices of the International Union of Biological Sciences with the financial aid of Unesco.

Many advances have been made in recent years in our knowledge of the physical conditions and chemical exchanges at the interface between mud and the bottom water of lakes, thanks to the development of various new techniques, and H. J. Elster (Germany), while emphasizing the services rendered to limnology by A. Thienemann's oligotropic-eutropic classification of lake types, made it clear, using Black Forest lakes and Lake Constance as examples, that a rigid adherence to the classical type concept is not justified, particularly as the chemical turnover in the hypolimnion is to a considerable extent influenced by hydrographical factors. O. Steinböck (Austria) supported this view by his thesis that in the case of upland lakes hydrographical factors are predominant: there are here no lake types but the waters have geographical characteristics, and are best classified as mountain lakes, perennial pools and temporary pools. In those of the second category, daily meteorological changes affect the whole depth of water, so that there is no stable layering. The oxygen content of the bottom water of the upland lakes depends not so much on the productivity of the lake as on organic material washed into it, so that a pseudo-eutropic condition may arise.

K. Strøm (Norway) and B. Dussart (France) dealt with certain little-known phenomena in the hypolimnion. The temperature of the bottom water with maximal density depends on pressure and hence is below 4° C. in the depths of great lakes. The existence of supposed subaquatic springs is often doubtful, for direct observation, as in the Lac d'Annecy, can seldom be made, and their presence is usually deduced from temperature, bottom conditions and faunistic peculiarities; but it can be shown, for example in Lake Geneva, that the phenomena in question may be caused by special hydrographical conditions.

Exchanges at the mud surface were considered by F. Ruttner (Austria), who reported on a striking natural experiment in one of the lakes at Lunz which illustrates the provisional nature of lake types. This 3-metre deep spring-lake is characteristically oligotropic, with a sparse plankton and without thermal and chemical layering. In autumn, however, after dry weather, considerable quantities of lime become dissolved as a result of the decay of the macroflora. The resulting solution of a higher specific gravity flows down into the now inactive funnel of the spring, giving a eutropic zonation, with the disappearance of oxygen, formation of hydrogen sulphide and development of an oligoaerobic plankton. The great extent of mud surface relative to water volume is largely responsible for the very considerable chemical exchanges, with a paucity of oxygen. Such exchanges also take place between water and dissolved colloidal substances, particularly humus. This is an important phenomenon in peaty waters, where the colloids, acting as cation and anion exchangers, control the ionic composition. W. Ohle (Germany) gave a good example of such an action in the case of a magnesium–calcium ratio which was 1 : 2 in electrolyte-poor water and as much as 1 : 7 in water rich in electrolytes.

Sedimentation studies were described by Mrs. W. Tutin (Great Britain) and E. Thomas (Switzerland). The latter has made a quantitative investigation of organic and inorganic sediments in various Swiss lakes, comparing oligotropic with eutropic conditions, considering in particular the nitrogen and phosphorus balance between mud and water in relation to production.

On the faunistic side, H. Järnefelt (Finland) came to the conclusion, from extensive studies of Finnish lakes, that no single factor studied up to the present can account for the nature of populations: a complex of causes must be involved. F. Lenz (Germany) supported this thesis with reference to the bottom fauna of the Lago Maggiore, which varies with meteorological and consequent hydrographical conditions. Contributions to a knowledge of these conditions were made by N. Della Croce and O. Ravera (Italy). The former has investigated oligochæte populations, the density of which depends in part on the particle size of the sediments. Ravera made an experimental study of the quantity of excrement produced in unit time by members of

the three oligochæte species of the lake bottom; characteristic differences were found, depending both on species and depth. G. P. Moretti (Italy) made, in the same connexion, a quantitative study of the cases of caddis larvæ, some found as deep as 300 m.

I. Findenegg (Austria) reported on the bottom faunas of lakes in the Kärntner region, which are known to limnologists for the frequent occurrence of the so-called meromictic lake type. It was found that the density of the bottom fauna was at least as great in oligotrophic as in eutrophic lakes. This is due to the low oxygen content of the eutrophic hypolimnion and to the greater vertical range of plankton in the transparent oligotropic waters and consequent greater fall of food material to the bottom.

A particularly interesting faunistic situation from the evolutionary point of view is provided by Lake Ochrida, on which S. Stanković (Jugoslavia) spoke. This pre-Glacial lake has a hypolimnion with a constant temperature throughout the year, and an endemic profundal fauna, with sub-species the nearest relatives of which inhabit the littoral zone, from which they are clearly derived.

Other valuable contributions were made by E. S. Deevey and D. G. Frey (United States) and by H. Züllig (Switzerland). A detailed report of the symposium will be obtainable from the Secretary of the International Union of Biological Sciences, Laboratoire de Physiologie Végétale, Sorbonne, Paris, or from the Istituto Italiano di Idrobiologia, Pallanza, Italy.

R. A. VOLLENWEIDER

THE IONOSPHERE DURING THE SOLAR ECLIPSE OF FEBRUARY 25, 1952

By C. M. MINNIS

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DURING the past twenty years, an intensive study has been made of the response of the ionized layers of the earth's upper atmosphere to changes in the intensity of the solar radiation incident on them. Most of the existing fund of knowledge on this subject has been built up from observations of the variations in ionospheric parameters which result from the diurnal and annual changes in radiation intensity caused by the rotation of the earth about its axis and around the sun. The slowness of these changes and the superposed perturbations arising from imperfectly understood large-scale tidal effects lead to difficulties in the analysis of such data.

An eclipse of the sun may be thought of as providing the conditions for a controlled experiment in the ionosphere during which a rapid change in the intensity of the incident radiation takes place but which is not, to a first approximation, further complicated by the normal diurnal changes. Ionospheric observations have, for this reason, been made during solar eclipses on many occasions since the first indirect measurements of Eccles[1] in 1919; but, since the end of the Second World War, few suitable opportunities have occurred of using modern ionospheric sounding techniques in this way. The totality belt for the 1952 eclipse extended from West Africa across the Anglo-Egyptian Sudan to Persia and was, in consequence, fairly accessible. The Department of Scientific and Industrial Research sent two expeditions to Central Africa: one to Ibadan, near Lagos, where the eclipse was partial, and another to Khartoum in the totality belt. At both stations measurements of the height and electron density of the ionospheric layers were made during the eclipse and during the control periods preceding and following it. In addition, observations were made at the Radio Research Station at Slough and at its outstations at Inverness and Singapore, all of which were near the edge of the eclipse area.

E- and *F*1-Layers

The sudden reversal in the rate of change of the radiation intensity during a total or near total eclipse ought, in principle, to make possible the calculation of the effective recombination coefficients which are measures of the rate of decay of ionization in the different layers. For the application of this technique in its simplest form, a necessary condition is that the ionizing radiation should be emitted uniformly from the whole of the sun's disk. Unfortunately, the character of the changes in electron density which are actually observed during eclipses casts considerable doubt on the validity of this assumption. For the 1940 eclipse, Higgs[2] found it to be untenable and attempted to explain his results by assuming that the radiation was emitted from four known areas of calcium flocculi in addition to a component assumed to come from a uniformly radiating disk. The best fit with the observed densities in the *E*-layer was obtained when the intensity of the disk component was put equal to zero; but, as Higgs himself points out, this is not a unique solution. It seems likely that the best fit was not the true one in this instance, particularly since the corresponding results for the *F*1-layer indicated a very large contribution from the disk.

Waldmeier suspected that the *E*-layer measurements made by Rydbeck during the 1945 eclipse might be consistent with the assumption that the ionizing radiation originated in those parts of the inner corona in which the emission line at 5303 A. was strong; a comparison of the ionospheric data with a contour map of the intensity of the 5303 A. line confirmed this[3]. A similar comparison between the ionospheric data obtained at Khartoum in 1952 and the coronal contours based on measurements made at the Pic du Midi tended to support Waldmeier's conclusion, although an unexplained discrepancy remained[4].

A later examination of the Khartoum data for the *E*-layer has shown that the distribution and relative intensities of the sources of radiation can, for this eclipse, be deduced with some precision from the ionospheric data alone, without the need for making any assumptions concerning the positions of the sources. The discrepancy mentioned earlier is then seen to be due to the existence of an intense narrow source on the west limb of the sun, the evidence for which on the coronal intensity map is not decisive. Confirmation of the positions and relative intensities of the sources, as deduced from the Khartoum results, has been obtained by applying a similar method of analysis to *E*-layer data obtained by Piggott[5] at Ibadan two hours earlier (Table 1).

Data on the sources of 5303 A. are given in Table 2. While there is an obvious similarity between

Table 1. Sources of *E*-Layer Ionizing Radiation, February 25, 1952

Source	Position angle (from N. pole)	Radial extent ($R_\odot$)	Intensity (per cent)
	Khartoum		
Kh 1	240°–320°	0·98–1·0	25
Kh 2	68°	0·64–1·0	8
Kh 3	320°	1·0	3
Disk	—	—	64
	Ibadan		
Ib 1	240°–295°	(*a*)	25
Ib 2	59°	0·8	8
Disk	—	—	67

(*a*) Assumed to be confined to the limb as inferred from Khartoum data.

the ionospheric and coronal sources, it would be unwise at present to conclude that they are identical, particularly since a consideration of the area and intensity of the west-limb source (Kh 1, Ib 1) leads to the conclusion that its intrinsic brightness is at least thirty times that of the uniform disk radiation.

The peak of the *F*1-layer at Khartoum was partly obscured by the *F*2-layer, and measurements of its electron density could not be made to the degree of accuracy required to allow the positions and intensities of the *F*1-layer sources to be derived. However, there is no doubt that the uniformly radiating disk model is not capable of accounting for the changes in density which actually occurred. On the other hand, a very good fit between the observed and calculated variations is obtained if it is assumed that the disk model derived from the Khartoum *E*-layer data is valid for the *F*1-layer also. There appears, therefore, to be evidence for believing that a close relation exists between the sources of ionizing radiation responsible for the *E*- and *F*1-layers.

The value of the electron density and its time derivative immediately before totality at Khartoum can be used to determine the effective recombination coefficient (α') for both *E*- and *F*1-layers if it is assumed that during totality the intensity of the ionizing radiation is zero; the values obtained, which are unlikely to be in error by more than 10 per cent on account of errors of measurement, are $\alpha' E = 1{\cdot}51 \times 10^{-8}$ cm.$^{-3}$ s.$^{-1}$ (125 km.) and $\alpha' F1 = 8{\cdot}2 \times 10^{-9}$ s.$^{-1}$ ($\sim$ 170 km.).

*F*2-Layer

It is not possible to account for the complex response of the *F*2-layer to an eclipse in terms of the modified Chapman-layer structure assumed for the *E*- and *F*1-layers, because tidal effects seem to play a predominant part at heights greater than 200 km. At Ibadan, the old *F*2-layer which began to form after sunrise but did not have time to attain its daytime density was occulted by a newly formed *F*2-layer which appeared soon after the maximum phase of the eclipse. At Khartoum also, soon after totality, a new layer formed between the *F*1- and *F*2-layers; but, although its density increased very rapidly, it quickly rose in height and merged into the normal *F*2-layer, the density of which had remained quite constant during the eclipse. The sequence of events in the *F*2-layer both at Khartoum and Ibadan, and also during the normal sunrise period, is suggestive of the generation of free electrons at a fairly low level and the vertical transport of this ionization to higher levels where the much lower recombination coefficient results in the very slow rate of decay normally associated with the *F*2-layer.

Table 2. Sources of Coronal Radiation 5303 A., February 25, 1952

Source	Position angle (from N. pole)	Corresponding *E*-layer sources
W. limb (Climax)	235°–330°	Kh 1, Kh 3, Ib 1
E. limb (Climax)	65°–100°	Kh 2, Ib 2
Disk (Pic du Midi)	78° (small area near limb)	Disk radiation
	103° (small area near limb)	
	Otherwise no outstanding features	

Es-Layer; Corpuscular Eclipse

An unusual and very deep minimum in the critical frequency of the sporadic *E*-layer occurred with a time-lag of about 90 min. after totality at Khartoum. Although no similar change had been observed during the control period, it would be speculative to suggest that it had any connexion with the eclipse.

It is usual to look for possible evidence of a corpuscular eclipse in the ionosphere about two hours before the optical one, but none was observed on this occasion. During the night preceding the eclipse, an ionospheric storm resulted in low and fluctuating values for the electron density in the *F*2-layer, and it is possible that storm effects would have masked any corpuscular eclipse effects which might have been present.

Acknowledgments. This work, a fuller account of which will appear in the *Journal of Atmospheric and Terrestrial Physics*, was carried out as part of the programme of the Radio Research Board; and this account is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

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MEASUREMENTS OF AGE BY THE CARBON-14 TECHNIQUE

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THE technique we have used for age determination by means of carbon-14 has already been described elsewhere in detail[1,2]. The essential difference from Libby's technique is the use of a proportional counter filled with carbon dioxide prepared from the sample. Two improvements may be of interest. The first deals with the removal of radon from the carbon dioxide. It was found that the radon originated from the calcium oxide used, obviously by contamination with radium. With another supply of calcium oxide all difficulties were removed and it was checked that radon present in the sample had been removed by the chemical treatment. Further, we have examined various suggestions mentioned in our paper for reducing the background. It was found that an extra anti-coincidence ring did not give any appreciable improvement. The efficiency of one ring is nearly complete; the lower efficiency found by Raeth *et al.*[3] is probably due to coincidences produced by gamma-

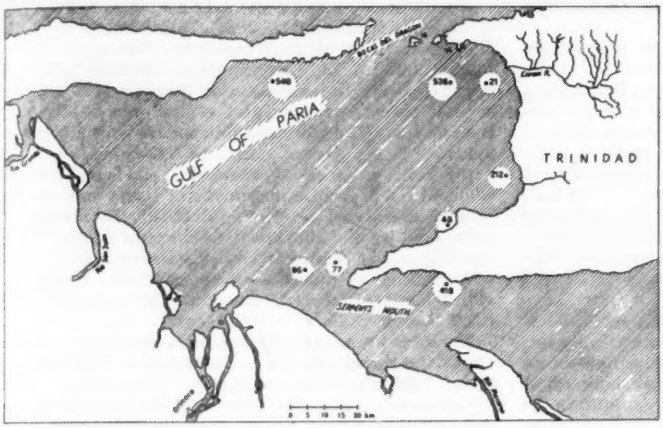

Fig. 1. Gulf of Paria. The numbers of the stations refer to Table 1

Table 1. SHELL SAMPLES FROM THE GULF OF PARIA

Samples from shell beds are marked with an asterisk. Stations 77 and 418 gave only a few scattered shells. 21 and 536 were close together

Station	Depth (cm.)	Age in years	Station	Depth (cm.)	Age in years
21*	0	720 ± 150	77	0	− 130 ± 130
536	70	1,645 ± 160	418	0	60 ± 130
48*	0	655 ± 150	86	53	2,605 ± 240
212*	0	720 ± 200	86	150	3,175 ± 160
548*	10	1,020 ± 140			

rays. An extra layer of mercury proved to be very effective, and we did not find any significant difference between lead and mercury. The background was reduced from 4/min. to 2·64/min. for a layer between the counter and the anti-coincidence ring, and to 3·04 if the extra layer, with the same thickness of 2 cm., was outside the anti-coincidence ring. For special reasons the second arrangement has been used during recent months.

A half-life for carbon-14 of 5,570 years was used for the calculations. The errors given are the statistical errors in the counts, since, according to our experience, no other sources of errors (impurities of the sample, etc.) play any part. Checks on the reliability of the method and remarks on the treatment of the samples are included in the text. Unless otherwise stated, the samples were treated at least with diluted hydrochloric acid. Generally the expected age was not known before the measurement. The following summarizes our results up to July 1954.

Geological Samples

The first group of samples consisted of shells from different parts of the Gulf of Paria (South America) (see Fig. 1). The greater part of the samples contained less than 1 gm. of carbon (which is required for our normal work). A complete discussion of the results in relation with an extensive geological survey is in the press[4], but the general conclusions were as follows. From geological evidence it was anticipated that in more or less recent times the arm of the Orinoco had broken into the gulf. By this 'catastrophe', shell-beds were 'killed' by the fresh water. Indeed, samples 21, 48, 212 and 548 all had the same age. Samples 77 and 418 were expected, for various reasons, to be of recent origin. The rates of sedimentation which can be calculated from the samples at various depths are reasonable.

For the calculations we assumed the specific activity of the shells to be the same as for organic carbon of the same age. Previously it was claimed by Anderson and Libby[5] and by Kulp *et al.*[6] that the activity of the shell carbon was higher, but unpublished measurements of ours give no evidence of any difference; these studies are being continued, but the results for samples 77 and 418 already indicate the activity of recent shells to be the same as for organic carbon. One Tertiary sample has been dated as a check. If no exchange of carbon dioxide had taken place, it would not have contained any carbon-14. Nevertheless, the activity was $3 \pm 1{\cdot}5$ per cent of the activity of recent carbon. This, however, is not very significant; moreover, the history of this sample was not known (it came from a museum).

(2) Lowering of the Dutch coast relative to sea-level. This is a scientific problem as well as a practical one. An extensive programme is being carried out on behalf of the committee which studies the possibilities of the closure of the estuaries in south-west Holland. Up to now, about forty samples (peat and shells) have been dated. At the same time, pollen diagrams of the peat are being made. In Fig. 2 we give only a few results which pertain to samples from a large excavation at Velsen (North Holland). The curve demonstrates that the rate of sinking of the bottom was about 35 cm./century some 7,000 years ago, and about 10 cm./century at present. We cannot go into details of the geological problems which have to be solved, such as depth of sample relative to sea-level at time of formation, and disturbance of

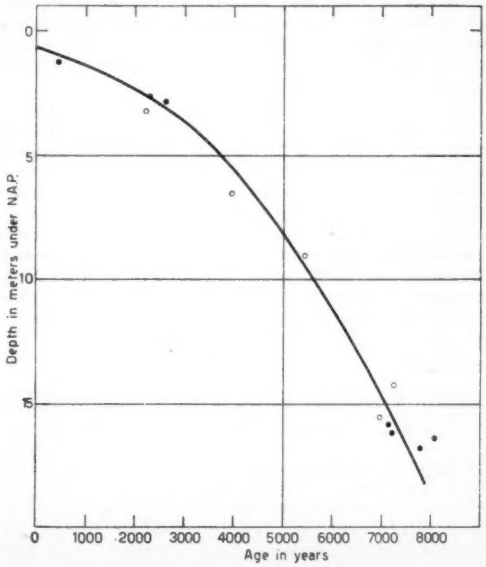

Fig. 2. Lowering of Dutch coast relative to sea-level. ●, peat samples; ○, shells. N.A.P. = Ordnance Datum

original position; van Straaten[7] has prepared a preliminary report on these problems.

(3) Bones of domestic animals from underneath lava in south-west Syria, provided by Dr. W. J. van Liere (Food and Agriculture Organization, Damascus). These lava formations are found over a large area and they were expected to be fairly young (from a geological point of view). The present samples came from Kheurbet el Ambachi. Generally, bones are not very suitable for carbon-14 measurements; but part of the present material had obviously been charred in the absence of oxygen. It was nearly black and it contained as much as 25 per cent of carbon. The age was found to be 4,075 ± 160 years.

Archæological Samples

(1) Dried wheat from a Badarian cemetery in Egypt, submitted by Dr. H. Meyers. The grains were scarcely more than thin foils; they were boiled first with hydrochloric acid. The age was found to be 5,110 ± 160 years, which is somewhat younger than expected. We are trying to get a better sample.

(2) Charred wheat, submitted by Prof. Rotmahler. The sample was in a very good condition. It could be considered as presenting the oldest agriculture in Central Europe (*Bandkeramik*). It was found in Westeregeln (close to Magdeburg). The expected age was between 4,000 and 6,000 years, though the lower limit is better in accord with present views. We find 6,200 ± 200 years.

Other samples bearing on the same problem are being assembled, but according to personal information, recent evidence is in support of the present result.

(3) Charred wood from a ceramic band settlement (*frühe Bandkeramik*), submitted by Dr. H. Grosz (Bamberg). It was found in Wittislingen, south-west Germany (for details see ref. 8). The sample was separated into two fractions: one fraction was extracted with hot sodium hydroxide and the other boiled with hydrochloric acid and the residue after extraction with hot sodium hydroxide solution examined. The results were 6,090 ± 180 years and 6,000 ± 140 years, respectively. There is no systematic difference; this indicates that no humic acids, etc., had infiltrated. Therefore, we give the average result: 6,030 ± 110 years. For the discussion see also sample (2).

(4) Charred wood from Donderen (Netherlands), submitted by the Biological–Archæological Institute, Groningen (director, Prof. A. E. van Giffen). Dated as Hamburgian. The sample contained few roots, which were selected so far as possible, and it had not been completely converted into coal.

The first measurement, after treatment with cold hydrochloric acid, gave 6,950 ± 160 years. Obviously this age is not compatible with a Hamburgian date, therefore, it was decided to sacrifice the rest of the sample and to separate it into various fractions, as will be described in more detail elsewhere. The results are:

(*a*) Material extracted by hot hydrochloric acid	2,190 ± 300 years
(*b*) Material extracted by hot sodium hydroxide	7,630 ± 140 ,,
(*c*) Carbon, remaining after (*a*) and (*b*) and after extraction of cellulose	7,365 ± 400 ,,

The large errors in (*a*) and (*c*) are due to the fact that these fractions contained only about 0·3 gm. of carbon. Obviously the sample did contain some fairly recent material, but nevertheless the age of the rest was still younger than expected. Our conclusion is that the discrepancy cannot be due to an error in measurement.

(5) Charred wood, well preserved, from Een (Drenthe, Netherlands), also submitted by the Biological–Archæological Institute, Groningen. Age found, 7,030 ± 140 years. The expected age was approximately the same as for the previous sample, so that these results suggest a new critical study of the chronology of the Late Palæolithic in the Netherlands.

(6) Four samples of charred wood and one of calcined bone, from a necropolis of thirty barrows at Toterfout-Halve Mijl (North Brabant, Netherlands), submitted by the Biological–Archæological Institute, Groningen (see thesis of Dr. W. Glasbergen[9]).

According to pollen analysis, tumulus 4 was the oldest barrow, dating from about 1500 B.C. We find 3,375 ± 200 years.

Tumulus 8 was important, since it gave information about the burial ritual. It was dated as Bronze Age, about 1100 B.C. We find 3,055 ± 90 years.

Tumulus 1*B* contained an early form of 'Deverel'-urn. According to pollen analysis, it should date from a period close to tumulus 4. We find 3,450 ± 85 years. It follows from this result that the Continental 'Deverel' culture is not related with the later urn-fields, but represents an invasion of British elements. Recent archæological evidence has confirmed this conclusion.

A sample of charred wood from an urn-field, also at Toterfout-Halve Mijl, gave an age of 7,865 ± 240 years. The expected age was some 2,500 years, and this difference is so large that it is beyond doubt that the sample did not come from that urn-field. Indeed, it did not form part of the contents of an urn, but it was found very close to it. It must be ascribed to a Mesolithic settlement; indeed, some flint artefacts were found which were probably Mesolithic.

The urn itself contained some calcined bone, which contained less than 1 per cent of carbon. Moreover, some roots had grown into it which were difficult to remove. Nevertheless, we have made an age-measurement, and find 905 ± 300 years. As might be expected, this is much too young.

(7) Charcoal sample from the primary grave of a Dutch disk barrow, tumulus II, near Postel (Belgium), not far from the Dutch frontier, submitted by Prof. S. J. de Laet (Ghent). We find 3,185 ± 120 years.

It was expected to date from a period between tumulus 1*B* and tumulus 8 described under (6). This is confirmed by our result.

(8) Wood from a Swiss lake dwelling at Thayngen Weier, submitted by Dr. W. U. Guyan (Schaffhausen). The wood was very well preserved. We find 4,735 ± 130 years.

(9) Charred wood from a megalithic tomb (passage grave) at Diever (Netherlands). In agreement with the views of Prof. van Giffen, the age turned out to be 3,850 ± 150 years.

(10) Charred wood, well preserved, from Haule (Netherlands), also submitted by the Biological–Archæological Institute, Groningen. Mesolithic. We find 7,525 ± 200 years.

It had been dated by Libby as 7,900 ± 300, which agrees with our result. Pollen analysis suggested an age of somewhat more than 7,000 years.

(11) Wood from a site at Jemgum (Ost Friesland, Germany). It came from a so-called *Flachlandsiedlung* preceding the first artificial dwelling mounds (*terpen*). In accordance with the age expected by Dr. W. Haarnagel, we find 2,335 ± 70 years.

(12) Charred wood from a Late Neolithic barrow near Hijken (Drenthe, Netherlands). Age expected

by Prof. van Giffen about 1400 or 1500 B.C. We find 3,300 ± 150 years.

(13) Charred wood from a Bronze Age barrow near Grootebroek (North Holland, Netherlands). Age, in accordance with the age expected by Prof. van Giffen (see ref. 10), 3,000 ± 140 years.

(14) Three samples from a three-period barrow in Oudemolen (Drenthe, Netherlands) submitted by Prof. A. E. van Giffen. The original barrow was Late Neolithic, the second period was a barrow with timber circle and, finally, this barrow was covered by another barrow in the Late Bronze Age. In the first and in the last grave charcoal was found, whereas the second period only gave huminiferous sand derived from the original posts. In historical order the results we obtained are: 3,505 ± 125 years, 3,180 ± 120 years, and 3,620 ± 120 years.

Obviously the age for the huminiferous sand is too young. This may be partly due to infiltration of recent huminiferous material from above. Unfortunately, no samples of sand from close to the post holes had been taken as a check. Moreover, the two samples of charred wood from the first and the last period may not give the real age of these two barrows. The dead were probably cremated in a hollow tree; if our samples originated from the central part of this tree—and no special care was taken to avoid that—then an error will be made which is equal to the age of the tree.

(15) Three samples of charred wood from a group of barrows near Wijster (Drenthe, Netherlands). For details see ref. 11. Pollen analysis dated these as "Iron Age". Fragments of bronze artefacts were dated as La Tène (Late Iron Age).

Our results, which are in accordance with this archæological evidence, are: 1,985 ± 150, 2,025 ± 175, and 2,350 ± 300 years. The last sample was re-measured as 2,130 ± 140 years.

(16) Wood from underneath the previous Walburg church at Groningen (Netherlands), submitted by Prof. A. E. van Giffen. For a historical study of the Walburg church see ref. 12. For various reasons this wood sample, consisting of two large blocks, with a cross-section of 50 cm. × 50 cm., was measured several times, in the course of nearly two years. Unless otherwise indicated, new carbon dioxide was prepared each time.

(*a*) First measurement (May 1952)	850 ± 200 years
(*b*) Sample from heart of beam	1,200 ± 150 ,,
(*c*) Same carbon dioxide preparation as (*b*)	1,140 ± 100 ,,
(*d*) Top of block, which might have been infiltrated with recent material	1,080 ± 120 ,,
(*e*) This sample, and the following samples, were taken from a block, sent back by Libby	820 ± 90 ,,
(*f*) Same preparation as (*e*)	1,010 ± 80 ,,
(*g*) New carbon dioxide preparation	905 ± 65 ,,
(*h*) Material extracted by hot sodium hydroxide	990 ± 140 ,,
(*i*) Material extracted by hot hydrochloric acid	1,035 ± 150 ,,
(*j*) Carbon dioxide prepared from carbon which had been measured by Libby	1,100 ± 200 ,,

The average value is about 1,000 years. The deviations from the average are not significant enough to draw conclusions from them. (Denoting the deviation of an individual result by Δ, and the statistical error given in the last column by σ, we find 1·25 for the average of Δ^2/σ^2 (which has to be close to 1). The probability that a value of 1·22 or a larger one happens by chance in a series of ten measurements is about 0·4.) Among others, the result of (*h*) and (*i*) indicates that no appreciable amount of young organic material has infiltrated into the sample. We have also prepared pure cellulose from it, but this will be measured with high accuracy in a larger counter.

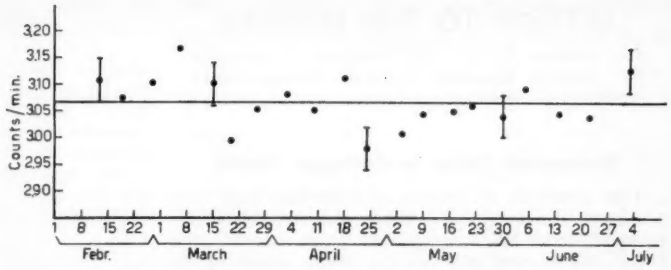

Fig. 3. The background in counts/min. during six months

The main reason why this sample was measured so often was that it was dated by Libby as 2,220 years (± 200). After samples (*a*), (*b*) and (*c*) had been measured, Libby re-measured his first preparation of carbon, but with essentially the same result (3,133 ± 300 and 2,500 ± 270 years). More recently he has measured a new preparation of carbon (from the same block of wood); result, 2,053 ± 345 years.

Finally, the same sample has been used as a cross-check by two other carbon-14 stations. According to private communications, the results were 1,065 ± 130 (Heidelberg, Germany) and 950 ± 80 years (Royal Institution, London). In Heidelberg a carbon dioxide counter is used; in London the counter is filled with acetylene. The origin of the discrepancy between Libby's results and the European results is not yet clear. We mention this, because for sample 8 of this list the agreement was good. Since the wood did not belong to the church itself, we do not know its age exactly. According to ref. 12, however, an age of about 1,000 years does not seem to be unreasonable.

To conclude, we give in Fig. 3 a survey of the backgrounds measured in the past six months. As a rule, the background was measured every week from Saturday to Monday. Fig. 3 does not give significant indications for variations of the background. The average of Δ^2/σ^2 (see earlier comment) is 1·4, whereas the *a priori* probability for this value (or a larger one) is 0·15. Perhaps there is a gradual decrease of the background, but it is too small to be significant. Our normal procedure is to take the average background during the past four weeks, giving double weight to the last two measurements.

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LETTERS TO THE EDITORS

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Structural Units in Collagen Fibrils

The structure of fibrous proteins has long been a subject of controversy. X-ray and electron microscope evidence has accumulated which suggests that single chains may not run the whole length of the fibril, but that the latter is made up of an aggregation of smaller parts of quite definite size. In collagen the sub-unit has been considered[1] to be a protofibril of size about 640 × 12 A., although recently Schmitt[2] has proposed a unit of about 2000 × 50 A., which he has named 'tropocollagen'. Striations of axial lengths about 210 A. (particularly in developing material[3]) and 70 A.[4] are also observed in electron micrographs of collagen. It is of interest to note that evidence for structure of size approximately 200 A. is found in α-keratin[5] and 230 A. in fibrin[6], although the recurrence of this figure may be no more than coincidental.

We have obtained X-ray diffraction evidence from dry collagen fibres which also suggests that the predominant 640 A. period is divided into sub-units of length about 210 A., although these are not necessarily discrete particles. In native tendon, new X-ray photographs show that the protofibrils are associated laterally into bundles.

In Fig. 1 are plotted the square roots of the observed intensities for the first twelve orders of diffraction of the macro-period (691 A. in this case) against sin θ/λ for dry rat-tail tendon under slight tension. From this plot we have endeavoured to trace out the structure factor of the diffracting unit, and we find that the probable zero positions fit in remarkably well with those for a uniform sphere or ellipsoid of length ~ 230 A.

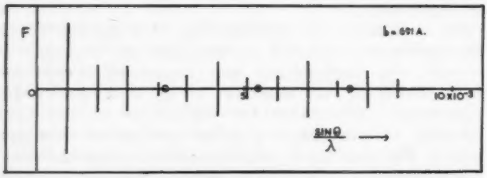

Fig. 1. Square roots of the observed intensities of diffraction orders of the macro-period of dry rat-tail tendon. The circles represent the zero positions for diffraction from a uniform sphere of diameter 230 A.

Fig. 2 shows the central region of a photograph of very dry rat-tail tendon taken in an evacuated camera of high resolving power with nickel-filtered copper-$K\alpha$ radiation. Around the central beam can be seen a roughly ellipsoidal halo of diffuse scattering. Applying Guinier's method[7], we have determined the size of the particle which would produce this scattering, assuming it to be an ellipsoid of revolution; we find its axes to be about 200 A. in the fibre direction and about 40–90 A. at right angles. These dimensions correspond very closely with those of the apatite crystallites associated with collagen in bone, which are, moreover, oriented in the same way[8].

On the other hand, when native collagen fibres are sealed in thin-walled glass capillary tubes before they have dried out, they produce an X-ray fibre diagram, Fig. 3, showing a number of equatorial reflexions of spacings (Table 1) larger than that usually ascribed to the interplanar spacing of single protofibrils. Further, the usual single strong interchain reflexion is now seen to be split up into two components, one on the equator at 12·6 A. and the other just off it on a layer line of spacing of ~200 A. Attempts to index these reflexions suggest a packing arrangement with dimensions perpendicular to the fibre of:

$$a = 62\text{ A.};\quad c = 76\text{ A.};\quad \beta = 125°.$$

The layer line at 200 A. may correspond to the repeat of a helix or super-helix. There is also some indication of fine structure on the 10 A. layer line.

The intensity variation along the equator suggests an arrangement of bundles of about 40–50 A. diameter, each bundle consisting of about seven protofibrils hexagonally packed. The above unit cell would contain two such bundles. On drying, shrinkage is accompanied by loss of order, the bundles eventually scattering independently. Once this stage has been reached the ordered arrangement is not reproduced on wetting, although the individual bundles swell. Irreversible drying phenomena are commonly found in other more truly crystalline proteins.

The overwhelming intensity of the first order of diffraction of the 640 A. period and the asymmetry of the banding as seen on electron micrographs show that this unit is the true repeating entity along the axis of the collagen fibre in its native state.

Evidence has accumulated from a study of low-angle line shapes[9] and from swelling[10] which suggests that within the macro-period there exist alternating regions of greater and less order—interbands and bands respectively—the latter being the sites occupied by stains, such as phosphotungstic acid. We have recently shown[11] that the effects of tension on air-dried fibres are consistent with this picture.

From the improved high-angle X-ray diagram obtainable from fibres held under tension, we have

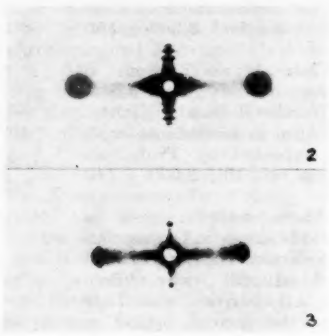

Fig. 2. Central region of X-ray photograph of vacuum-dried rat-tail tendon, fibre axis vertical

Fig. 3. Central region of X-ray photograph of moist native tendon, fibre axis vertical

Table 1. Equatorial or Row-line Spacings of Reflexions in Fig. 3, with Rough Intensities

12·6	13·5	14·9	17·0	18·8	20·5	24·5	31	37	49 (A.)
VS	VS	M	M	M	W	M	W	S	S

shown that the polypeptide chains within the well-ordered interbands almost certainly have a helical configuration[12].

The diffuseness of the high-angle pattern, however, indicates that these crystalline regions are of small extent, perhaps only 50 A. long. It is not yet clear how the various regions are arranged to give the 640 A. macroperiod with its apparent 200 A. substructure. Nevertheless, the whole system is a highly ordered one, as shown by the sharpness and extent of the low-angle diffraction pattern.

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Phosphorylation coupled with the Oxidation of Ferrocytochrome c by Heart Sarcosomes

Nielsen and Lehninger[1] have recently demonstrated the incorporation of phosphorus-32 into organic phosphate during the aerobic oxidation of ferrocytochrome *c* by rat-liver mitochondria in the presence of adenosine diphosphate, magnesium, versene, antimycin A and inorganic phosphate labelled with phosphorus-32. In the present communication, a net phosphorylation is shown to accompany the same reaction catalysed by rat-heart sarcosomes (mitochondria).

The sarcosomes were isolated in 0·21 *M* sucrose, 0·01 *M* versene, *p*H 7·4, as described previously[2]. The washed sedimented sarcosomes were suspended in 0·021 *M* sucrose, 0·001 *M* versene, *p*H 7·4, to give a concentration of 8·5 mgm. protein/ml., and the suspension was kept at 0° C. for 30 min. to allow oxidation of residual substrates. Four volumes of recently boiled and cooled glass-distilled water were then added, so that the sarcosomes were now suspended in a medium 1/50th the tonicity of rat blood. This hypotonic pretreatment of the sarcosomes was suggested by the work of Lehninger[3] on the phosphorylation coupled with the oxidation of reduced diphosphopyridine nucleotide by liver mitochondria. The concentration of the final suspension medium giving maximum phosphorylation was found in experiments which will be published elsewhere.

Table 1. Phosphorylation coupled with the Oxidation of Ferrocytochrome *c* by Rat-Heart Sarcosomes.

See text for reaction mixture and procedure. *p*H of reaction mixture, 7·4; 14·4 min. at 22° C.

	Cell 1	Cell 2		Cell 3	
Cytochrome *c* (μmoles)		Ferri	Ferro	Ferri	Ferro
Initial	0	0·18	1·42	1·40	0·17
Final	0	1·28	0·32	1·54	0·03
△	0	1·10		0·14	
Hexose monophosphate (μmoles)					
Initial	0·022	0·022		0·022	
Final	0·058	0·244		0·057	
△	0·036	0·222		0·035	
△ (corr.)	—	0·186		0	
$\triangle P/\frac{1}{2}\triangle$ cytochrome *c*	—	0·34		0	

A 1-cm. spectrophotometric cell (cell 2 in Table 1) contained 90 μmoles phosphate, 60 μmoles glucose, 3 μmoles versene, 120 μmoles fluoride, 0·6 μmole adenosine monophosphate, 0·6 μmole adenosine diphosphate, 127 units hexokinase[4] and 1·6 μmoles cytochrome *c* (89 per cent reduced, 11 per cent oxidized) in a total volume of 2·8 ml. A reference cell (No. 1) contained all these ingredients except the cytochrome *c*. Magnesium chloride (0·1 ml. of 0·15 *M*) was added to each cell and the optical density at 600 mμ of cell 2 read against that of cell 1 until a steady reading was obtained (this is necessary because of the formation of a slight turbidity when the magnesium is added). At zero time, 0·1 ml. of the diluted sarcosomal suspension (containing 0·19 mgm. protein) was added to each cell, and the oxidation of the ferrocytochrome *c* followed by measuring the increase of optical density at 600 mμ. After 14·4 min., when 1·10 μmoles of ferrocytochrome *c* had been oxidized (the cytochrome *c* was now 20 per cent reduced, 80 per cent oxidized), trichloroacetic acid was added to each cell and the hexose monophosphate formed determined according to the method previously described[5].

The small amount of hexose monophosphate found in the reference cell is mainly due to the non-oxidative phosphorylation of glucose by adenosine diphosphate catalysed by myokinase and hexokinase[5]. Phosphorylation derived from the oxidation of traces of substrates in the sarcosomal preparation will also be included in the hexose monophosphate found in this cell. The hexose monophosphate found in cell 2 minus that found in cell 1 represents the phosphorylation coupled with the oxidation of ferrocytochrome *c*. The corrected value (0·186 μmole) is many times greater than the sensitivity of the analytical method (about 0·01 μmole) and corresponds to a ratio of phosphorus to $\frac{1}{2}$ (ferrocytochrome *c*) of 0·34. This ratio is about the same as the ratio of phosphorus – oxygen atoms (0·32) obtained when ascorbic acid was oxidized by the same preparation in the presence of catalytic amounts of cytochrome *c*. It is likely, then, that the phosphorylation obtained with ascorbate[6] occurs in the reaction between cytochrome *c* and oxygen.

The preparation of ferrocytochrome *c* used was made by reduction of a stock solution of cytochrome *c* by hydrogen in the presence of platinum black, the hydrogen then being removed by a stream of

nitrogen and the platinum by centrifugation. Cell 3 in Table 1 was an additional control in which the stock solution of cytochrome *c* (11 per cent reduced) was used. No phosphorylation beyond that found in the control cell 1 was found in cell 3, showing that the prior reduction of the cytochrome *c* was entirely responsible for the corrected phosphorylation measured in cell 2.

The demonstration that phosphorylation can be coupled with the oxidation of ferrocytochrome *c* is in complete agreement with the findings of Nielsen and Lehninger[1]. From the point of view of the mechanism of the phosphorylation, it is important to establish whether the ratio of phosphorus to $\frac{1}{2}$ (ferrocytochrome *c*) is equal to or exceeds 0·5 (corresponding to a ratio of phosphorus to oxygen molecules of 1). Our results to date suggest that the ratio in heart sarcosomes might not exceed 0·5, but it is quite possible that improvements in technique will result in ratios approaching 1. With liver mitochondria, Nielsen and Lehninger[1] have obtained ratios between 0·44 and 0·86 for this reaction. Liver mitochondria oxidizing ascorbic acid in the presence of catalytic amounts of cytochrome *c* also yield ratios of phosphorus to oxygen atoms approaching one [7].

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Infra-red and Ultra-violet Absorption Spectra of Proteins in the Solid State

The potassium bromide pressed-disk technique for the determination of infra-red spectra in the solid state was first developed in our laboratories during the period 1947–49 under contract with the U.S. Air Materiel Command, but, as restricted information, was not formally published at that time[1]. The method has since been used by Stimson[2] and independently by Schiedt[3,4]. The technique has been successfully applied by us to a number of proteins, and the purpose of this communication is to direct attention to this application. A major advantage of the technique lies in the ability to determine both infra-red and ultra-violet absorption of the same protein sample under identical conditions.

The technique was briefly as follows: 'A.R.' grade potassium bromide, ground to 200-mesh in a mullite mortar, was dried at 110° C. Samples of purified proteins, also ground to 200 mesh, were mixed to give the desired concentration (usually 1 per cent) and the mixture was passed several times through a 200-mesh sieve. 200 mgm. of mixture was placed in a cylindrical 0·5-in. (1·27-cm.) steel die which was enclosed in a larger cylinder connected to a vacuum pump and McLeod gauge. The system was evacuated for approximately five minutes at 40 microns pressure; lower pressures were not more advantageous, but evacuation was necessary or the disks clouded and fractured from occluded gases after pressing. With the system still being evacuated, pressure, usually 150,000 lb. per sq. in., was applied for a few seconds to one minute; longer pressing offered no advantage. Air was then admitted. The clear disk was removed from the die and weighed. A companion disk of pure potassium bromide was also made. Our apparatus could be electrically heated, but heat was not useful in the pressing of potassium bromide. It was helpful in pressing materials of lower melting point such as thallium halides or silver chloride. The maximum variation in weight between disks was 30 mgm. in 200 mgm., but it was possible to hold the variation to not more than 5 mgm. in a given series. Maximum variation in thickness in such a series was about 0·0025 cm. in disks with an average thickness of 0·0635 cm. As also shown by Stimson[2], these differences are compensated, and uniform distribution is demonstrated by the fact that the quotient, optical density/per cent times weight, is reasonably constant.

Preliminary measurements were made on several mechanical properties of the pressed disks of potassium bromide as compared with the crystalline halide. For this purpose a 1-in. die was used. Young's modulus of the pressed potassium bromide was $1{\cdot}17 \times 10^{11}$ dynes/cm.^{2}, as compared with $0{\cdot}76 \times 10^{11}$ dynes/cm.^{2} for a grown crystal. Pressed potassium bromide had a coefficient of linear expansion of $38{\cdot}8 \times 10^{-6}$ cm./cm./deg. C., as compared with $35{\cdot}0 \times 10^{-6}$ cm./cm./deg. C. for a grown crystal (Baxter[5] reports $37{\cdot}0 \times 10^{-6}$ cm./cm./deg. C.). Tensile strength of the pressed halide averaged 1,000 lb./sq. in. compared with 400 lb./sq. in. for grown crystals.

The proteins used in these studies were crystalline bovine serum albumin and chymotrypsinogen (gifts of the Armour Laboratories); and egg albumin, cytochrome *c*, and lyophilized whole rabbit serum prepared in our laboratory. The infra-red spectra were obtained with a Perkin-Elmer *IR* Spectrophotometer, Model 21, through the courtesy of Dr. Seymour Levine and Mr. H. J. R. Stevenson, of the Sanitary Engineering Center, U.S. Public Health Service, Cincinnati. The ultra-violet spectra were obtained with a Beckman Model *DU* quartz spectrophotometer.

Typical infra-red spectra are shown in Fig. 1. All proteins, of course, display the expected bands in the 3 μ, 6 μ and 6·5 μ regions. Bovine serum albumin, egg albumin and cytochrome *c* have a shoulder at about 3·25 μ; this shoulder is slightly evident in whole rabbit serum but is absent in chymotrypsinogen. All show bands of varying intensity at about 3·42 μ. All except chymotrypsinogen (which shows at most a slight shoulder) have a band at 6·9 μ. All have a band at 7·2 μ; this is particularly pronounced for chymotrypsinogen and is shifted slightly to 7·15 μ. Egg albumin and rabbit serum show separate bands at 7·7 μ and 8·1 μ, but the first of these is barely discernible in cytochrome *c* and in chymotrypsinogen; the absorption is broad over this region for bovine serum albumin, with only slight suggestions of two peaks. Slight bands are present in the 8·55 μ–8·65 μ region for all proteins except chymotrypsinogen. Slight bands are also present for all proteins in the

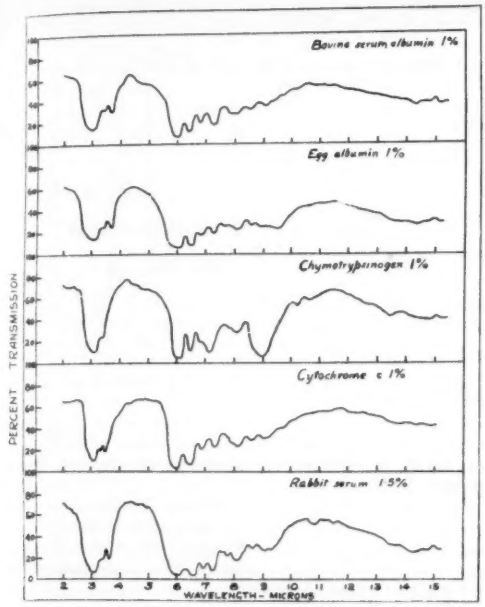

Fig. 1. Infra-red absorption of proteins in potassium bromide disks

9·0 μ region, but this absorption is very pronounced for chymotrypsinogen. With slight differences in detail, these spectra compare favourably with the corresponding ones reported by Klotz[6] for cytochrome *c* and bovine serum albumin in films on silver chloride, and they appear to resemble closely those reported by Fong *et al.*[7] for crystalline human serum albumin.

The ultra-violet spectra of the solid proteins were compared with the spectra of solutions in 0·1 *N* hydrochloric acid and in 0·1 *N* sodium hydroxide. The spectra of egg albumin in the solid state and in acid exhibited a peak at 278 mμ, whereas in base the peak was shifted to 290 mμ. Bovine serum albumin in the acid solution had a peak at about 278 mμ and in basic solution at 290 mμ; in the disk, although there was a shoulder at 280 mμ, peak absorption occurred at 265 mμ. Chymotrypsinogen appeared to be relatively unaffected by *p*H; solutions in acid and base both showed absorption peaks at 280 mμ. The disk had a shoulder at 280 mμ but a more pronounced peak at 272 mμ. Cytochrome *c* in solution displayed an acid peak at 275 mμ and a basic peak at 290 mμ. The disk had a selective absorption, but not pronounced peaks, at 262 mμ and 280 mμ. All the ultra-violet absorptions thus far described can be attributed, of course, to aromatic amino-acids. None of the proteins absorbed appreciably at wavelengths longer than 300–320 mμ, with the exception of cytochrome *c*, which absorbs at longer wavelengths because of its prosthetic group.

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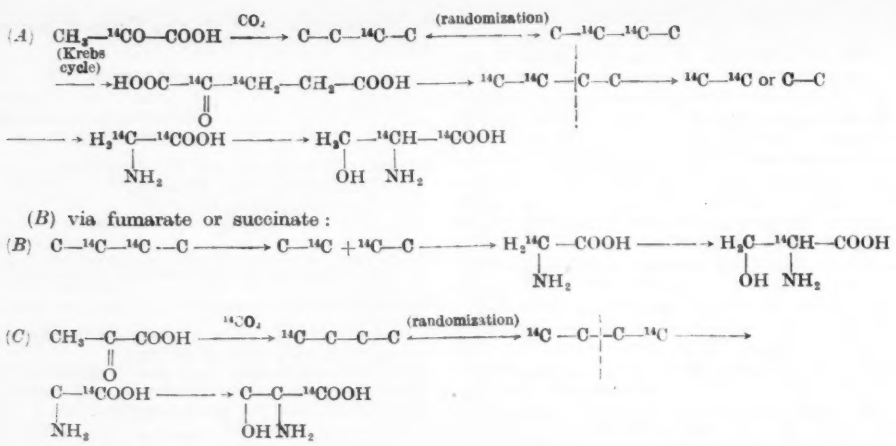
Origin of Glycine and Serine in Bakers' Yeast

The ready interconversion of glycine and serine in biological systems has been well recognized for several years. Somewhat less attention has been paid to the origin of this pair of compounds from other metabolites, although evidence has been presented[1] to indicate that serine may arise prior to glycine, through transformations involving pyruvate or other C_3 compounds.

Work in this laboratory has been focused upon the conversion of pyruvate-2-^{14}C to amino-acids in bakers' yeast. Using this substrate and the yeast samples described previously[2–6] for examination of other amino-acids, the distribution of isotope was observed for the serine and glycine isolated from the yeast hydrolysate. Both compounds were obtained in pure form by adsorption of the hydrolysate on a 'Dowex-50' column and fractional elution according to the method of Stein and Moore[7]. Threonine and alanine were removed by separation on cellulose powder columns. Purity of the samples was checked by paper chromatography.

It will be noted from Table 1 that the isotope patterns in carbons 1 and 2 of serine and glycine are very similar, with carbon 2 only slightly higher in activity than carbon 1. This confirms the ease of interconversion of these two compounds. However, when alanine from these yeast samples was degraded, it was found to be labelled primarily in carbon 2 (67 per cent in the aerobic culture, 90 cent per in the anaerobic). The alanine side-chains of phenylalanine[8] and tyrosine[6] also showed preferential labelling in carbon 2, as might be expected if these units arose from the pyruvate administered. It is therefore evident that the pathway from pyruvate to serine is less direct, and must involve one or more steps which permit isotope equilibration in positions 1 and 2 of serine.

This condition could be satisfied if serine were formed through glycine, by forward operation of the Krebs cycle, followed by α,β-cleavage of a C_4-acid. The glycine carbon atoms would thus correspond to carbons 2 and 3 of α-ketoglutarate or glutamic acid, which were, as shown previously[8], equally labelled in this yeast sample. Sequence *A* illustrates the suggested formation of glycine from pyruvate and its conversion to serine:



Reverse operation of the cycle (scheme *B*) would, on the other hand, provide preferential labelling in carbon 2 of glycine.

The slightly higher isotope concentration in this position of both glycine and serine (Table 1) may suggest a partial contribution from this pathway.

Fixation of carbon-14 dioxide with non-isotopic pyruvate is also being examined in this yeast. Under these conditions, glycine and serine become labelled within one hour, shortly after aspartic acid becomes radioactive, whereas alanine remains unlabelled during periods up to five hours. This again supports the conclusion that serine probably does not arise directly from pyruvate. Degradation of serine reveals the isotope mainly in the carboxyl group. This could be expected from equilibration of the C_4-acids formed, followed by their conversion to glycine (scheme *C*), since simultaneous operation of the cycle (scheme *A*) would in this experiment provide only unlabelled glycine and serine.

Table 1. Distribution of Carbon-14 in Glycine and Serine utilizing $CH_3{}^{14}COCOOH$

Amino-acid	Carbon atom	Radioactivity Aerobic		Anaerobic	
		c.p.m. × 10^{4}*	per cent of total	c.p.m. × 10^{4}*	per cent of total
Glycine	Total	1·81	100	1·75	100
	1. COOH	0·85	47	0·70	40
	2. CH_2NH_2	0·96	53	1·05	60
Serine	Total	2·84	100	1·38	100
	1. COOH	1·16	41	0·49	42
	2. $CHNH_2$	1·60	57	0·55	48
	3. CH_2OH	0·06	2	0·11	10

* Specific activity (total) is expressed as counts per min. per m.mol. amino-acid; the activities of individual carbon atoms are counts per min. per m.mol. carbon. All values are given in terms of the undiluted amino-acids.

It is concluded that the serine ⟷ glycine interconversion in bakers' yeast is fed primarily from C_4-acids through glycine, in contrast to the situation in animal metabolism, where serine is thought to arise directly from pyruvate.

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Electrophoresis of Human Red-Cell Stroma

In an attempt to provide a chemical basis for an understanding of the morphological appearance of human red cells and of the changes in red-cell morphology in various hæmatological disorders, we have fractionated red-cell stroma preparations by electrophoresis. Three lipid-containing protein fractions have been separated, two of which migrate readily in veronal buffer at *p*H 8·6 ($\mu = 0{\cdot}1$). Red-cell stroma was prepared initially in the manner described by us[1], but in addition was washed twice with 0·1 *M* potassium dihydrogen phosphate and three times with distilled water. A stromal extract obtained with 0·2 *M* ammonium hydroxide and containing 18 μgm. of tyrosine equivalents of protein[2] was then subjected to paper electrophoresis[3].

Fig. 1 shows the electrophoretic mobilities of the fractions as determined on the basis of azocarmine *B* and sudan black binding resulting from staining after electrophoresis. The dye concentrations were estimated colorimetrically and are expressed as optical densities.

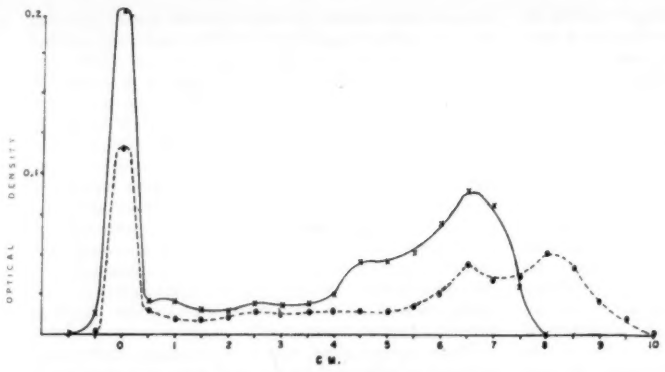

Fig. 1. Electrophoretic mobility pattern of red-cell stroma. Solid line: azocarmine binding; broken line: sudan black binding

Similar studies were carried out on a preparative scale by zone electrophoresis on cellulose slabs using Whatman No. 1 standard grade cellulose powder. These fractions were examined serologically and it was found that the blood group substances *A* and/or *B* were located in the slowly moving fraction in high concentration. *Rh* substance is present in the crude stroma extract but, on electrophoresis, neither fraction was sufficiently strongly inhibitory to the *Rh* antibody to indicate the fate of this substance. Details of these studies will be published elsewhere.

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Renal Excretion of 17-Ketosteroids by Members of some Ethnic Groups living in Malaya

We have recently studied the 24-hr. renal outputs of 17-ketosteroids by normal adult males belonging to some of the well-defined, civilized ethnic groups living on Singapore Island and in the Federation of Malaya. The groups for which complete data have been obtained (a sample of twenty subjects was taken from each ethnic group) are Chinese, European and Malay. The Chinese were all of recent Southern Chinese origin, most of the Europeans were of recent English origin and most of the Malays were of recent 'Peninsular' origin. Work on other subjects belonging to both civilized and uncivilized groups has yet to be completed and evaluated. Meanwhile, the existing complete data are discussed briefly (Table 1).

The ages of the subjects were all within a range (17–46 yr.) over which the 17-ketosteroid excretion of normal male Europeans has been found to be relatively independent of age[1,2], and we are of the opinion that only a small fraction, if any, of the differences revealed in Table 1 can be attributed to disparities in the ages of the subjects.

The observations afford three pair-comparisons of the 17-ketosteroid excretions. Employing the arithmetic values and (in view of the non-homogeneous variances) having recourse to the Cochran and Cox[3] *t* statistic to test the significance of differences between the arithmetic means, it is found that the differences between the Chinese and European means and between the European and Malay means are probably of high statistical significance. However, the intra-sample distributions of 17-ketosteroid values approximate to 'log-normal'[4] rather than 'normal' form, and the validity of the test is therefore impaired. As the variances of the $\log_{10}$ (values) are fairly similar, 'Student's' *t* test has been applied to test the significance of differences between the means (namely, the $\log_{10}$ (geometric means), these latter being: Chinese 8·7, European 15·3, Malay 7·3), using for the purpose a pooled estimate of variance (0·02068). The comparisons yield: Chinese and European, $t = 5{\cdot}40$, $P < 0{\cdot}001$; Chinese and Malay, $t = 1{\cdot}66$, $P > 0{\cdot}05$; European and Malay, $t = 7{\cdot}05$, $P < 0{\cdot}001$, the probability (P) levels being taken from tables[5] of *t*. Differences as large as those observed in the first and the third pair-comparisons would be extremely unlikely to arise in random sampling from homogeneous populations, a finding which confirms that indicated by the less satisfactory examination mentioned earlier.

Little work of this type has yet been performed. It has been observed[6], however, that mature African and English males appeared to have very dissimilar excretions of 17-ketosteroids; and our results, rather similar to those of Barnicot and Wolffson[6] so far as the European subjects are concerned, likewise suggest

Table 1. Renal Excretion of 17-Ketosteroids by Samples of Twenty Adult Males

Each sample was drawn from a separate ethnic group. 17-Ketosteroids in urine estimated by the procedure (ref. 8) recommended by Warren (ref. 9), and creatinine by the method of Folin (ref. 10). Means and standard deviations of $\log_{10}$ (values) are shown in parentheses in columns 2 and 4, respectively

Ethnic group	24-hr. 17-ketosteroid excretion			24-hr. mean creatinine excretion (gm.)	Mean wt. (kgm.)	Mean age (yr.)
	Mean (mgm.)	Range (mgm.)	Standard deviation (mgm.)			
Chinese	9·2 (0·940)	3·9–17·5	3·26 (0·154)	1·45	53·3	23·2
European	16·0 (1·185)	10·5–27·9	4·82 (0·125)	1·87	73·5	31·8
Malay	7·8 (0·864)	4·4–14·9	2·89 (0·154)	1·42	57·1	32·4

that the excretions of other ethnic groups are lower. However, the two samples studied by Barnicot and Wolffson exhibited distinctly similar creatinine excretions, whereas our European subjects excreted appreciably more creatinine (on the average) than did our Chinese or our Malay subjects. Again, our European subjects were (on the average) appreciably heavier than those of the other ethnic groups—Barnicot and Wolffson have given no comparison of weights.

Our work suggests that there may be a correlation between 17-ketosteroid output on one hand and creatinine output and/or weight on the other. In this connexion it is pertinent to recall that evidence has earlier been found[7] of a correlation between the 17-ketosteroid and creatinine outputs of children of European origin.

A more rigorous statistical examination of our results (complicated by the fact that the distributions of some variates, but not all, are more nearly 'log-normal' than 'normal') is in progress. It is hoped that the investigations may (among other things) suggest a clinically more useful estimate of '17-ketosteroid status' than is afforded by the absolute 24-hr. excretion values themselves or is suggested by the correlation observed by Nathanson, Miller, Towne and Aub[7].

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Neurohypophysial Control of Follicular Maturation in the Domestic Fowl

Evidence from several sources[1-5] supports the view that the discharge of ovulation-inducing hormone from the hypophysis of the domestic fowl is mediated by a nervous mechanism, as in the rat[6]. The interval from 'excitation' for the release of the hormone to ovulation has been estimated to be of the order of 8–14 hr.[4,5,7]. In the present communication we wish to direct attention to results indicating that ovulations in the hen may be suppressed by the interruption, long before the estimated hour of release of the ovulation-inducing hormone, of processes presumably associated with maturation of the ovarian follicle.

The birds used, conditions of their maintenance, and experimental procedures have been described recently[4]. Hens selected for test were ovulating in 3-day 'closed' cycles[4]. The first or C_1 ovulation in such cycles occurs at about 6.00 a.m., the second or C_2 ovulation at about 10.30 a.m. on the next day. Ovulation does not take place on the third day of the cycle, but does so at 6.00 a.m. of the day thereafter to initiate a new cycle. The interval between C_1 and C_2 ovulations is thus about 28·5 hr., that between C_2 and C_1 ovulations about 43·5 hr. In the main body of experiments, the suppressing or 'blocking' agents were injected 38 hr. before expected C_1 ovulation, or 5–6 hr. following the preceding C_2 ovulation. The hens were palpated at appropriate hours to determine the occurrence or non-occurrence of ovulation on the day of expected ovulation or on the day thereafter. When the injected agent interfered with normal feed or water intake, the birds were forcibly fed and watered.

The suppressing agents included phenobarbital sodium, diallylbarbituric acid ('Dial'), pentobarbital sodium ('Nembutal'), the adrenergic blocking agent *SKF*-501, and the anticholinergic drug, atropine sulphate. Solutions of the barbiturates were prepared according to Fraps and Case[4], of *SKF*-501 and atropine sulphate as described by Zarrow and Bastian[3]. No attempt was made to determine the conditions of maximal suppressing action of the several agents.

Table 1. Suppression of C_1 Ovulation by Barbiturates and 'Blocking' Agents Administered 38 hr. before Expected Ovulation

Agent	Treatment Route*	Quantity	No. of hens injected	Ovulations suppressed No.	Per cent
Phenobarbital sodium	Sc.	100 mgm./kgm.	10	9	90
'Dial'	Im.	80 ,,	10	8	80
'Nembutal'	Sc.	60 ,,	11	6	55
SKF-501	Im.	10 ,,	9	7	77
Atropine sulphate	Ip.	150 mgm./hen	9	6	67

* Sc., subcutaneous; Im., intramuscular; Ip., intraperitoneal.

Results of injections 38 hr. before expected C_1 ovulation are recorded in Table 1. The significance of these results becomes apparent on comparing the effects of the same agents following administration at about 14 hr. before expected C_1 ovulation, that is, when injected for effect on the neural component of the mechanism causing release of the ovulation-inducing hormone specifically. Phenobarbital at 14 hr. suppresses few or no ovulations[1], in contrast with 90 per cent at 38 hr. 'Dial' and 'Nembutal' actually induce ovulation prematurely in some hens injected at 14 hr. before expected ovulation[1], whereas at 38 hr. the same barbiturates act only as suppressing agents.

A single injection of *SKF*-501 at 14 hr. suppresses 30–40 per cent of expected ovulations (unpublished observations), as against 77 per cent at 38 hr. The incidence of ovulations suppressed by the single 38-hr. injection of *SKF*-501 compares favourably with the results of two injections used by Zarrow and Bastian[3] for direct blockade of ovulation-inducing hormone release. These authors also reported that atropine sulphate suppressed C_1 ovulation following administration of the drug at hourly intervals for 12 hr., beginning some 8–10 hr. before expected ovulation. A single injection of the same agent at 38 hr. yields results of the same order.

The suppression of C_1 ovulation by barbiturates and 'blocking' agents injected 38 hr. before expected ovulation indicates almost certainly the blockade of

a nervous mechanism controlling some essential pre-ovulatory process. The direct suppression of the release of ovulation-inducing hormone is obviously improbable. It is suggested that the nervous activity in question controls the secretion of hypophysial hormone (or hormones) required for maintenance and function of the maturing ovarian follicle.

A fairly extensive body of circumstantial evidence might be marshalled in support of the view that the hen's maturing follicle secretes progesterone (or a physiologically equivalent steroid) and that this hormone, rather than œstrogen, 'excites' the mechanism for release of the ovulation-inducing hormone. On this view, the hen's maturing follicle may be said to undergo luteinization prior to release of gonadotrophin for its ovulation. Pre-ovulatory progesterone has been demonstrated in mammals[5], but apparently only following release of the luteinizing hormone for ovulation. The postulated pre-ovulatory luteinization of the hen's follicle may imply the existence of nervous and hypophysial functions usually associated with ovulation and post-ovulatory luteinization in the rat[6]. Further observations bearing upon this hypothesis will be presented elsewhere.

Note added in proof. The adrenergic blocking agent, 'Dibenamine', administered 38 hr. before expected C_1 ovulation but otherwise in accordance with procedures of van Tienhoven *et al.*[5], suppresses ovulation in more than 90 per cent of injected hens. This drug should therefore be included with effective agents listed in Table 1.

Thanks are due to Dr. A. E. Heming, of the Smith, Kline and French Laboratories, Philadelphia, for 'Dibenamine' and *SKF*-501, and to the Research Department of Ciba Pharmaceutical Products, Inc., Summit, New Jersey, for 'Dial'.

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Research on the Mammals of South Africa

A recent paper by Dr. L. Harrison Matthews[1] has raised several interesting points regarding the biological study of mammals in Africa. Most stress was laid on big game studies, and the fact that they must be done before the game has disappeared owing to the advance of civilization. In South Africa two big game animals, *Equus quagga* Gmelin, the true quagga, and *Ozanna leucophaea* (Pallas), the blue antelope, are already extinct as a result of indiscriminate hunting, while many other groups like the bontebok (*Damaliscus pygargus* (Pallas)) are approaching extinction.

While the activities of hunters have to some extent been curbed by severe legislation, large numbers of game animals have been destroyed in the Union of South Africa and still are being decimated in the Rhodesias and Bechuanaland in combating the tsetse fly. Furthermore, here as elsewhere, wherever game stands in the way of agricultural development, the game inevitably goes. Hence it truly becomes necessary to learn all that is possible of the animals concerned before it is too late. At the same time, as pointed out by Harrison Matthews[1], where game is being destroyed, splendid opportunities exist for the collection of skeletal material for study purposes, and scientific institutions should be given the chance to avail themselves of these opportunities.

The biological study of small mammals is equally important, but from a different point of view. Here the stress is not on the danger of extinction, which for the smaller forms is not very real, but on the various scientific and economic problems that small mammals, and particularly rodents, bring in their train. Possibly the most important of these is the danger of plague, which is transmitted by small mammals. Another is the economic importance of rodent epizootics, for example, the destruction of trees in forestry plantations in the Sabie area (Transvaal) in 1951 and the recent (1953) invasion of *Mastomys* (multimammate mouse) in the Springbok Flats area of the Transvaal.

The problem is further complicated by our incomplete taxonomic knowledge of our mammal fauna. Two recent books on this subject, by Roberts[2] and Ellerman, Morrison-Scott and Hayman[3], both fail to present a true picture of this, the first as a result of intensive splitting, the second by extreme lumping together of groups of doubtful affinities. As pointed out by Handley[4], "some portions of the world are still in the 'exploration and cataloguing' stage as far as mammalogy is concerned". This is very true of South Africa, and while this remains the case, biological knowledge of our fauna is bound to progress little. On the other hand, of course, to complete the circle, taxonomy cannot produce "a sifted, sorted, and simplified nomenclature" (Handley[4]) without a more detailed biological background than at present exists.

A certain amount of work on mammal biology has been done. The splendid work of the late Dr. C. J. van der Horst has already been mentioned[1]. Furthermore, the Plague Research Laboratory of the South African Institute for Medical Research has for a number of years been carrying out researches on the taxonomy and biology of plague-carrying rodents. Examples of this are to be found in the work of Davis[5,6], Oliff[7] and others.

A Zoological Survey was brought into being in 1936 by the Division of Veterinary Services and did valuable work on the carriers of animal-borne disease (see Thomas and Kolbe[8]). Unfortunately, this project died an untimely death, and nothing similar has since been attempted.

At the present moment efforts are being made to form a Division of Biological Survey, and various groups and individuals (see Meester[9]) have stressed the need for a body of this nature. However, these efforts are handicapped first by the lack of official support and secondly by the shortage of trained workers. It seems, therefore, that some time will elapse before concrete results can be expected. Delay, however, is inadvisable and may be fatal. As Harrison Matthews has pointed out[1], the advance of civilization in Africa will inevitably result, in a

relatively short period, in the destruction of the larger elements at least of the mammal fauna outside the game reserves. It is essential to learn what can be learnt while there is the time and the material.

At the same time, without belittling the isolated work done by the various groups and individuals mentioned by Harrison Matthews and here, there can be little doubt that the interests of science would be better served by a broader, more realistic approach. Even the Biological Survey mentioned above would have a restricted, national scope.

It seems, therefore, that the problem should be approached on an international basis, similar to that of the International Red Locust Control Board. The only organization with a more or less international scope in Africa at the moment is the Scientific Council for Africa South of the Sahara, which has already shown its willingness to co-operate in conducting studies on African mammals. In view of this it would seem highly desirable for the Council to interest itself in organizing a body for the purpose of conducting and correlating biological research on African mammals.

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Fine Structure of Exocrine Cells of the Pancreas

A cytological study has been carried out on exocrine cells of the pancreas of the mouse with the aid of the electron microscope. The tissue was taken from animals aged two to three months and fixed in osmic acid buffered[1] to a *p*H of 7·4. It was then embedded in *n*-butyl methacrylate and sections about 400–800 A. thick were cut. Similar tissue, also fixed in buffered osmic acid, was embedded in gelatine for sectioning and examination by light microscopy in order to compare the effects of osmium fixation with those obtained by other fixatives employed in previous studies[2,3].

One of the most conspicuous objects identified in pancreas cells by means of the electron microscope was the Golgi apparatus (Fig. 1). In each cell this usually consisted of several groups of three or four vacuoles in close association with the zymogen granules. The vacuoles were apparently closely pressed together, but were separated from each other by a dense transverse membrane about 450 A. thick (Fig. 1, *tm*). This membrane joined with a limiting membrane (Fig. 1, *lm*) which was often similar in appearance to the transverse membrane but which separated the vacuoles from the surrounding cytoplasm. In some instances the limiting membrane was thicker (about 900 A. in diameter) on one side of the vacuoles than on the other side. In other cases it was a tubular or bilamellar structure about 1500 A. wide containing cristæ and granules dispersed along its length. In the region of the Golgi vacuoles numerous granules about 650 A. in diameter, sometimes containing a minute single dense particle, were seen scattered in the adjacent cytoplasm. These observations are consistent with the view[3] that the Golgi apparatus, as seen in sections 4–5 μ thick, is a three-dimensional canal-like organelle with transverse striæ passing across its lumen.

The mitochondria were not of uniform appearance but tended to fall into three categories: (1) tubular bodies about 3 μ long and about 0·3 μ in diameter containing many fine cristæ close together; some of these possessed lateral or terminal 'buds'; (2) tubular objects about 2·5 μ long and about 0·3 μ in diameter with a thickening at one end and bearing distinct cristæ; (3) tubular inclusions about 3 μ long and about 0·3 μ in diameter showing evidence of vacuolation and poorly developed cristæ; the surface of these bodies was indented in the midline in such a way that they bore a superficial resemblance to *Paramecium*. These three types of mitochondria may actually represent different functional conditions of a single type or be indicative of age changes[4].

Objects identified as prozymogen bodies appeared to originate from mitochondria by a process akin to budding and contained cristæ. In the Golgi zone it was observed that such bodies contained some of the 650 A. granules mentioned above and that few cristæ were present. Other prozymogen bodies contained a dense inner core which was regarded as the first sign of a developing zymogen granule. Finally, a micrograph was obtained which left little doubt that the fully developed zymogen granules are sometimes dehisced from the prozymogen bodies. These observations support the view[3] that prozymogen bodies originate from mitochondria and receive some contribution from the Golgi zone before completing the synthesis of zymogen.

The zymogen granules were seen as dense oval or spherical bodies (Fig. 1, *z*) sometimes with an irregular spiky outline. Some of them contained very small granules (about 200 A. in diameter) which may be related to the granules found within the prozymogen bodies. The density of the zymogen granules was not attributed to their osmophilia, since in the gelatine sections, which were examined by the light microscope, it was seen that they were relatively non-impregnated.

The appearance of the endoplasmic reticulum[1] varied considerably from cell to cell. It is believed

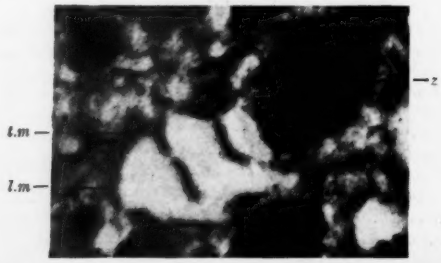

Fig. 1. Golgi apparatus, with transverse membranes (*t.m*) and limiting membrane (*l.m*), close to zymogen granules (*z*). Electron micrograph. × *c.* 25,000

that this was not due to vagaries in fixation but probably reflected the condition of cells in different phases of the secretion cycle[3]. In some cells the reticulum was represented by many parallel lamellæ or canaliculi, whereas in other cases only a vestige of this structure was retained and the cytoplasm resembled an open network.

Examination of the nucleus showed that along the nuclear membrane were many granules of the kind described by Ludford[5]. At first sight the nucleolus appeared to consist of an anastomizing opaque reticulum, but careful examination revealed that the strands of the reticulum actually consisted of granular material.

When osmium-fixed, gelatine-embedded sections were examined with the ordinary light microscope and the results compared with those obtained in previous studies[2,3] it was found that: (1) buffered osmic acid renders the tissue so brittle that thin (3–4 μ) sections can rarely be obtained; (2) it preserves lipids; (3) there is no specific impregnation of mitochondria, Golgi apparatus or prozymogen bodies by the osmium. It may be emphasized here that the fact that lipids are preserved in osmium-fixed gelatine-embedded preparations does not signify that they are retained in *n*-butyl methacrylate-embedded material. It is quite probable that some lipids are lost in preparing material for the electron microscope, and that vacuoles in such material actually represent the site of this substance.

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Chemical Composition of Uredospores of Wheat Stem Rust (*Puccinia graminis tritici*)

ONE approach to the problem of controlling wheat stem rust is the study of the chemistry of the parasite. As part of an investigation into the chemical nature of wheat stem rust, a preliminary examination has been made of uredospores of *Puccinia graminis tritici*. When uredospores of mixed races are subjected to the action of 72 per cent sulphuric acid for 24 hr. at room temperature (23° C.) and then heated with 2 *N* sulphuric acid in a sealed tube immersed in boiling water for 16 hr., D-glucose, D-mannose and D-arabitol are liberated. These three substances were identified by paper chromatography using ethyl acetate – acetic acid – water (3 : 1 : 3)[1]. By means of a cellulose column and the same irrigating solvent, enough of each of these three components was separated in order to provide crystalline derivatives thus:

D-Arabitol pentaacetate,	m.p. 73° C., $[\alpha]_D^{23}$ + 37·4° (chloroform)
D-Mannose *p*-nitroanilide,	m.p. 221° C., $[\alpha]_D^{23}$ − 404° (pyridine)
1,2,3,4,6α-D-Glucose pentaacetate,	m.p. 108° C., $[\alpha]_D^{23}$ + 105° (chloroform)

The literature shows that glucose and mannose have been identified in uredospores of wheat stem rust by paper chromatography, but no crystalline derivatives were prepared and it was not possible to state whether they were the D- or the L-sugars[2]. So far as we are aware the work reported herein constitutes the first proof of the identity of D-glucose, D-mannose and D-arabitol in uredospores. The five-carbon sugar alcohol, D-arabitol, is seldom encountered in natural products, although it has been reported in lichens[3].

Quantitative analyses, using the method of Dubois *et al.*[4] for the sugars and of Lambert *et al.*[5] for D-arabitol, indicated that the uredospores contained 2 per cent D-glucose, 19 per cent D-mannose and 3 per cent D-arabitol on a dry-weight basis.

Work is in progress to ascertain the nature of the carbohydrate compound(s) from which the above three substances are derived.

We thank Prof. Fred Smith (University of Minnesota) and Prof. J. G. Dickson (University of Wisconsin, Madison) for their interest in this work.

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Seed Dressings for the Control of Wheat Bulb Fly

GOUGH[1] has referred to the serious damage caused by wheat bulb fly (*Leptohylemyia coarctata* Fall.) in Great Britain in 1953 and discussed various means of preventing or reducing attacks. Of the possible methods of chemical control, seed dressings seemed worthy of investigation; previous experiments had given conflicting but usually negative results. One of the possible reasons for this was the length of time between the date of sowing and the egg-hatching period, and we therefore laid down two field-experiments to study this time-factor. The seed dressings were: (1) a standard proprietary one containing 1 per cent of an organo-mercurial fungicide applied at 2 oz./bush.; (2) 40 per cent gamma-BHC containing 0·8 per cent of an organo-mercurial applied at 3 oz./bush.; (3) 40 per cent dieldrin containing 0·6 per cent of an organo-mercurial also applied at 3 oz./bush.

There were two sowing dates, an early one in October or November, and a late one in December or January. The six treatments, that is, three seed dressings × two sowing dates, were randomized among four blocks in exp. *A* (peat soil) and three blocks in exp. *B* (acid peat). Both fields had previously been cropped with potatoes and were known to have a very high population of wheat bulb fly eggs of the order of 3–5 million per acre.

Table 1

	Exp.	Early sowing A–13.XI.53. B–29.X.53			Late sowing A–6.I.54. B–17.XII.53			S.E. 5 per cent
		Control	Dieldrin	BHC	Control	Dieldrin	BHC	
No. attacked shoots in millions/ac. (approx. equivalent to larval count)	A	1·90	1·60	1·53	1·01	0·73	0·50	—
	B	2·20	2·30	2·35	1·17	0·77	0·95	—
Per cent attacked shoots	A	43·1	34·3	34·1	79·6	65·0	37·3	—
	B	53·7	53·8	55·7	96·4	74·9	73·9	—
Per cent attacked shoots (angular transformation)	A	41	36	36	64	54	38	4·7
	B	47	47	48	79	62	61	13·0

In both fields by April the early-sown wheat had tillered well, masking the heavy larval attack. In exp. *A* in the late-sown (January 6) plots the gamma-BHC plots were uniformly good, the control plots uniformly poor and the dieldrin plots intermediate. In exp. *B*, where the late sowing was on December 17, the BHC plots were moderate, the controls a complete failure and two of the three dieldrin plots intermediate.

In May the same visual differences were still apparent on exp. *A*, except that the dieldrin plots were much improved relative to the controls, which were a complete failure; the early-sown plots continued to grow away from the attack. On exp. *B*, all the late-sown plots were failures and the attack had caused considerable thinning of the early-sown plots.

Plant samples were removed from five (exp. *A*) or seven (exp. *B*) unit areas on each plot at the end of March. The unit areas were two adjacent and parallel 1-ft. lengths of row. These samples were stored in a refrigerator until they could be examined and the numbers of attacked shoots and larvæ counted.

As only one larva survives in any one shoot[2] the absolute number of larvæ on the late-sown plots (where no tillering had taken place) was much smaller than on the early-sown plots. The results (Table 1) are therefore best compared on a percentage basis, and the analysis of variance has been made on an angular transformation.

Thus it is clear that the treatments have had little or no effect on the early-sown wheat, but have had a marked and significant effect on the late-sown treatments on field *A*. The differences on field *B* are not significant. Whether the lack of effect (or reduced effect) on field *B* is due to the different conditions or to the somewhat earlier date of sowing is not certain, but the latter is a reasonable assumption.

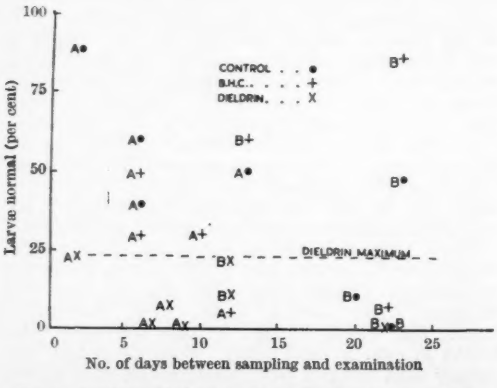

Fig. 1. Condition of wheat bulb fly larvæ from late-sown plants treated with BHC or dieldrin seed-dressing. The numbers of larvæ examined for exp. *A* are much greater than for exp. *B*

During a previous trial it had been noted that there was a slightly higher proportion of dead larvæ inside plants grown from aldrin- and dieldrin-treated seed than from BHC-treated and untreated seed, and the condition of the larvæ was therefore recorded in the present trials. Unfortunately, the length of time taken in dissecting and examining many thousands of plants rendered a direct comparison of the relative proportions of dead larvæ unreliable, and the effect is most clearly seen in a graph (Fig. 1), when the percentage of apparently normal larvæ for each of the later-sown treatments is plotted against the number of days elapsing between collection and examination. The remaining larvæ were either dead or classified as moribund or abnormal.

It is clear that dieldrin is having a marked effect on the larvæ in the plants, though the effect of BHC is less certain. It was, however, noted during the examination of the plants that many of those in the late-sown BHC treatments had a minute hole or tear in the first leaf consistent with the attempt of a larva to enter, though there were no signs of larvæ having been in these plants. It would appear, therefore, that the main effect of the BHC had been to prevent entry of the larva, and that of dieldrin had been to kill the larva after entry. This would explain the poor appearance of the dieldrin plots in the early stages and their subsequent improvement. As the larvæ were not killed until some time after entry, it seems likely that the dieldrin was taken up by the plant. This apparent systemic effect of dieldrin has been independently confirmed by workers in the Department of Insecticides and Fungicides at Rothamsted.

Insecticidal seed dressings are widely applied to cereals, and their use is being rapidly extended to other crops; but knowledge on their mode of action is meagre. Lange *et al.*[3] showed that wireworms died when confined in soil with lima beans dressed with BHC. Dogger and Lilly[4] suggested a repellent action, and this appears to be the general assumption. Seed treatment with insecticides can be regarded as a special method of soil application, and Starnes[5], Howe[6], Shapiro[7] and Kozlova and Dvortzova[8] have recorded mortality of insects feeding on or in various parts of plants growing in soil treated with BHC and other chlorinated hydrocarbons. In view of all these observations, it would seem desirable to study the mechanism of the protection afforded by seed treatments.

The seed dressings were prepared by the Department of Insecticides and Fungicides, Rothamsted Experimental Station, and we are indebted to Dr. C. Potter of that Department for this facility and for reading this communication in draft. We also acknowledge the help of several colleagues and of Mr. W. R. Green and Mr. T. A. Saul, who provided

the sites and carried out all the cultivations. This work is supported by a grant from the Agricultural Research Council.

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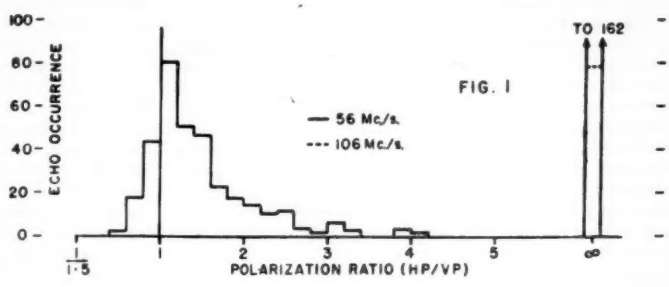
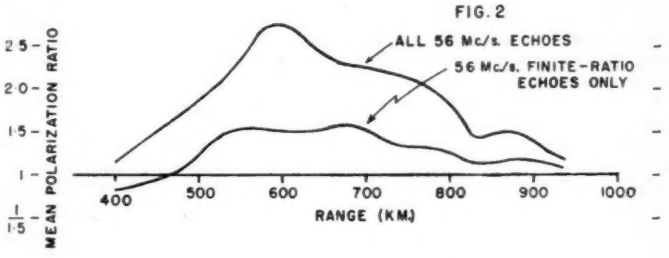
Polarization of Radio Echoes from Auroræ

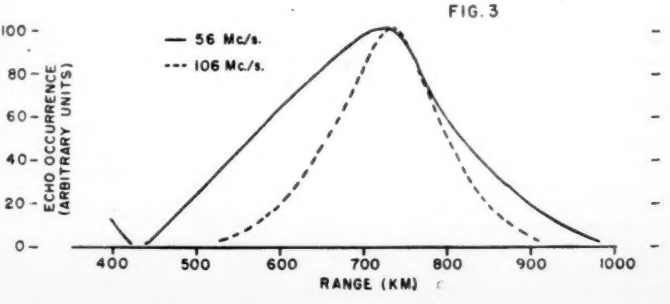
Notable variations in the polarization of radio echoes from auroræ have been observed at Saskatoon (52·1° N., 106·6° W.), using frequencies of 56 and 106·5 Mc./s. Theories of very high-frequency radio propagation predict the maintenance of the transmitted state of polarization under normal ionospheric conditions. An examination by Moore[1] of amateur radio transmissions by 'auroral propagation' indicated that this was also the case when aurora was present. Observations by Bowles[2] confirmed this conclusion, although exceptions occurred when aurora was overhead. More recently, Harang and Landmark[3], in reporting on back-scatter echoes during aurora, mentioned that 35 Mc./s. echoes were sometimes completely depolarized and sometimes nearly plane polarized, and that 74 Mc./s. echoes were plane polarized in the same sense as the transmitted signals. The Saskatoon observations are apparently the only ones that have been made so far where it has been possible to verify the auroral origin of the echoes[4].

The apparatus consisted essentially of two radar units transmitting horizontally polarized signals toward magnetic north on frequencies of 56 and 106·5 Mc./s., and a multiple antenna system designed to detect the angle of arrival and various types of polarization of the resulting echoes from auroræ. The 56 Mc./s. receiving antennæ consisted of a high, horizontally polarized Yagi; a low, horizontally polarized Yagi; a low, vertically polarized Yagi; and a low, circularly polarized antenna which could be alternated rapidly between right-handed and left-handed circular reception. A common receiver was used for these antennæ, a radio-frequency switch alternately connecting the two antennæ of a selected combination to the receiver. The first two antennæ were designed primarily to determine the angle of arrival of the echoes[4]. Only a horizontally and a vertically polarized Yagi were used for reception of 106·5 Mc./s. echoes. The received signals were presented on a cathode-ray tube as a range-amplitude display. The traces for each antenna combination were shifted vertically in synchronism with the radio-frequency switching. The displays were photographed using short time exposures. To obtain the polarization ratios plotted in Figs. 1 and 2, the amplitude ratios obtained from the photographs were normalized using a factor calculated from the horizontally and vertically polarized propagation patterns of the antennæ. This normalization factor is a function of angle of arrival and hence of range.

Observations on 56 Mc./s. during the period from December 1953 to August 1954 showed a large variation in the polarization ratios of the echoes. A strong degree of de-polarization was exhibited by a large proportion of the echoes. Fig. 1, based on the measurement of 489 56 Mc./s. echoes, is a histogram of the occurrence of echoes with various polarization ratios. For the 'finite ratio' group (66 per cent) of the 56 Mc./s. echoes, the most probable polarization ratio (horizontal to vertical component of field-strength) was 1·1 and the mean power ratio was 3 decibels. The 'infinite ratio' group (34 per cent of the echoes)







were substantially plane polarized in the sense of the transmitted signals. The mean power ratio, including both types of echoes, was 5 decibels. An exact division of the echoes into the two types was not possible because the relatively small signal-to-noise ratios (0–26 db.) made precise measurement of amplitude difficult, and the transition from one classification to the other was not sharply defined. The presence of polarization ratios of less than unity is believed to be due to experimental error. Observations with the circularly polarized antenna showed approximately equal amplitudes for left- and right-handed senses of rotation. The ratio of the circularly polarized antenna signal to the horizontally polarized antenna signal was practically constant. The polarization ratios (horizontal to vertical) sometimes differed widely for echoes occurring simultaneously but at different ranges. Also, the polarization of the echoes was observed at times to change from the plane to the de-polarized state, or vice versa, within a period of minutes.

Fig. 2 shows the variation of the mean normalized polarization ratio as a function of range. There appears to be a significant increase in the polarization ratio in the range 500–900 km. The region indicated by these ranges approximates to the meridian section of the Chapman echo surface[5], where the radar line of sight is perpendicular to the earth's magnetic field at *E*-region heights.

All observations of the polarization of 106·5 Mc./s. echoes (June–August 1954) have shown only plane polarization in the same sense as the transmitted signals. The seventy-eight echoes recorded in this period are shown in Fig. 1 by the dotted line. Instantaneous polarization relationships and relative occurrence of 56 and 106 Mc./s. echoes could not be inferred from the observations, since simultaneous display of polarization effects on the two frequencies was not possible with the apparatus employed. However, the change-over from one frequency to the other was accomplished within a few seconds, and general relationships could be determined.

Fig. 3 is a plot of echo occurrence against radar range. The shape of the 106 Mc./s. distribution is only approximate because of the much smaller number of echoes available. Apparently the 106 Mc./s. occurrence is largely restricted to the range interval in which high polarization ratios are obtained on 56 Mc./s. The occurrence of echoes is controlled by a number of factors: the propagation pattern of the antenna, the latitudinal variation of auroral occurrence, the earth's curvature, and the attenuation effect which limits occurrence of echoes to low angles of elevation. Correlations of polarization ratios with types of echoes (diffuse and discrete), or with types of visible aurora (homogeneous and rayed structures), have not yet been attempted. Two processes which could cause de-polarization of the signals are the magneto-ionic effect and multiple scatter within the reflecting region. Of the two, the latter seems the more likely. If the primary reflexion is by coherent scatter from long trails of ionization lying along the lines of the earth's magnetic field, aspect attenuation will limit the back-scattered signal to regions satisfying the criterion of perpendicularity. Multiple scatter will cause a broadening of the scattering polar diagram and thus permit echoes to be obtained from somewhat beyond the Chapman echo surface. In addition, over-dense volumes in the ionized region[6] will themselves possess omnidirectional polar diagrams and thus further extend the echoing region. This condition should occur oftener at the lower frequency.

This work has been made possible by financial assistance from the Defence Research Board of Canada and by loan of equipment from the U.S.A. Air Force Cambridge Research Center.

A. G. McNamara
B. W. Currie

University of Saskatchewan,
Saskatoon. Aug. 26.

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Titanium Nitride and Titanium Carbide as Semiconductors

It is well known that titanium nitride shows the electric properties of a typical metal[1]. In fact, the specific resistivity ρ is lower than that of titanium metal itself. We have re-examined these experiments, using van Arkels's technique[2] of deposition from the vapour phase for the preparation. Our results, given in Table 1, agree fairly well with those of the earlier investigators.

By the same method we have prepared layers of titanium nitride (TiN) on sintered aluminium oxide and quartz glass. The thickness of these layers varied between 1 and 25 μ. The layers on aluminium oxide have essentially the same properties as the titanium nitride deposited on tungsten wire. The small differences may be due to the uncertain thickness of the layer or perhaps to small impurities. The layers on quartz glass, on the other hand, show completely different electric behaviour, which resembles that considered typical for semiconductors. The specific resistivity at room temperature is $10–10^3$ times as high as for the samples on tungsten and aluminium oxide. In a certain temperature-range the temperature coefficient of the resistivity is negative. The position and height of the maximum depends on the particular kind of sample. The resistivity at 800° C. is almost the same for all layers on quartz glass. It is still higher than that of titanium nitride on tungsten or aluminium oxide. The Hall coefficient R has a negative sign and is essentially the same for both kinds of samples.

The structure of layers from both sides after removing the base materials has been examined by X-ray diffraction. We found no difference between the metallic and semiconducting titanium nitride. No impurities could be detected, and the lattice constant

Table 1. Electric Properties of Different Samples of Titanium Nitride

Sample No.	Base material	ρ 20° C. (Ω cm.)	ρ 800° C. (Ω cm.)	Temp. coeff. of ρ between 700° and 800° C.	Hall coeff. (R) (cm.³/coulomb)
1	Tungsten wire	$1·65 \times 10^{-3}$	$5·82 \times 10^{-5}$	$+ 3·2 \times 10^{-3}$	
I_{Al}	Aluminium oxide	$4·6 \times 10^{-3}$	$1·2 \times 10^{-4}$	$+ 2 \times 10^{-3}$	$- 1·2 \times 10^{-4}$
IV	Silica	$1·4 \times 10^{-2}$	$1·8 \times 10^{-4}$	$- 2 \times 10^{-3}$	
I°	Silica	$3·9 \times 10^{-4}$	$1·6 \times 10^{-4}$	$- 4 \times 10^{-4}$	$- 1·3 \times 10^{-4}$

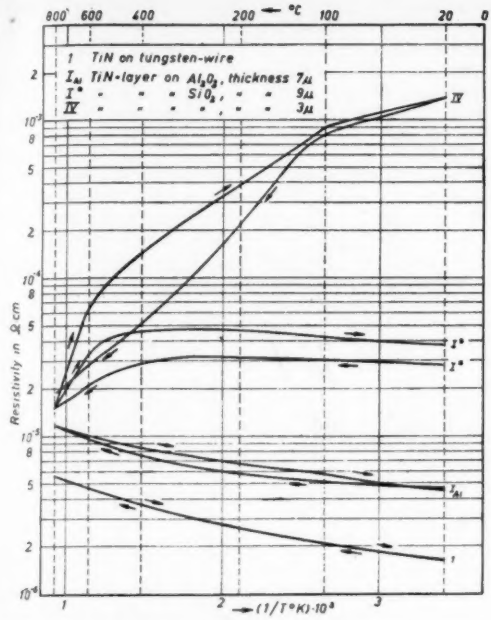
800 600 400 200 °C 100 20 0
I TiN on tungsten-wire
I_{Al} TiN-layer on Al_2O_3, thickness 7μ
I° " " " SiO_2, " 9μ
II " " " " " 3μ
Resistivity in Ω cm
$(1/T°K)\cdot10^3$

Fig. 1

has exactly the same value in both cases (4·2346 ± 0·0002 A.). Fig. 1 shows the relation of the specific resistivity to temperature for typical samples. Some numerical results are given in Table 1. Essentially the same behaviour has been observed for titanium carbide and mixed crystals of titanium nitride and carbide.

A full description of the experiments and the theoretical discussion will be published elsewhere.

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Point Source and Sink in a Parallelepiped

The potential distribution in a parallelepiped arising from a point source and sink is of practical importance in the measurement of the thickness of plates and tubes[1,2], and the electrical conductivity of semiconductors[3]. A common practical arrangement employs four collinear equi-spaced contacts: current I is passed between the outer pair, and the potential difference V between the inner pair is measured. If the contacts are aligned centrally parallel to the longest side 2α of a rectangular block of material, its width being 2β and its thickness γ in units of the electrode spacing, the conductivity is given by the triple series:

$$\sigma = \frac{I}{\pi V} \sum_{-\infty}^{\infty} \sum_{-\infty}^{\infty} \sum_{-\infty}^{\infty} (-1)^n \left\{ [(2n\alpha + 1)^2 + 4m^2\beta^2 + 4r^2\gamma^2]^{-1/2} - [(2n\alpha + 2)^2 + 4m^2\beta^2 + 4r^2\gamma^2]^{-1/2} \right\}$$

The difficulty in computing this series lies in the slow convergence of the single series:

$$s = \sum_{-\infty}^{\infty} [(n^2 + x^2)^{-1/2} - (n^2 + y^2)^{-1/2}],$$

when x and y are large. Warren[2] applied the Euler–Maclaurin summation formula to obtain approximations, and other workers have offered no alternative formula.

Although it is not difficult to show that

$$s = \int_{-\infty}^{\infty} \left[\frac{H_0^{(1)}(xt) - H_0^{(1)}(yt)}{e^t - 1} \right] dt,$$

and thence to obtain the alternative expansion

$$s = \left\{ 2\log(y/x) + 4 \sum_{n=1}^{\infty} [K_0(2\pi nx) - K_0(2\pi ny)] \right\},$$

this result does not appear to have been published hitherto.

It is a simple matter to reduce triple summations to a calculable form by means of this transformation, and the result may be readily extended to series involving higher inverse powers of $(n^2 + x^2)$ and $(n^2 + y^2)$. Such series are important in solid-state crystal theories, where they have usually led to tedious approximations, although recently a more powerful approach has been described[4].

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Dielectric Increment of Sodium Alginate as a Function of Polyion and Counter-Ion Concentration

A number of linear polyelectrolytes—acid as well as basic—give high dielectric increments in aqueous solution, when compared with less asymmetric proteins and simple dipolar ions.

The sodium salt of alginic acid (poly-β-*d*-mannuronic acid) has been shown recently to have dielectric properties in aqueous solution similar to the other polyelectrolytes studied, namely, high dielectric increments which show anomalous dependence upon concentration (see Fig. 1), dielectric dispersions at radio-frequencies which are strongly dependent upon concentration, decrease of increments and change of dispersions with addition of small amounts of simple electrolytes, and decrease of increments and change of dispersion with decrease of dielectric constant of solvent (water changed to ethanol–water)[1]. It was thought of interest to investigate in more detail the effect of excess counter ions.

The ellipsoid method[2], which permits measurements with solutions with comparatively high electric conductivity, was used for the determination of dielectric constants, which were made at various frequencies in the range 30 Mc./sec. to 30 kc./sec., so that the dispersion curve due to the solute(s) was obtained in each case. From this the dielectric con-

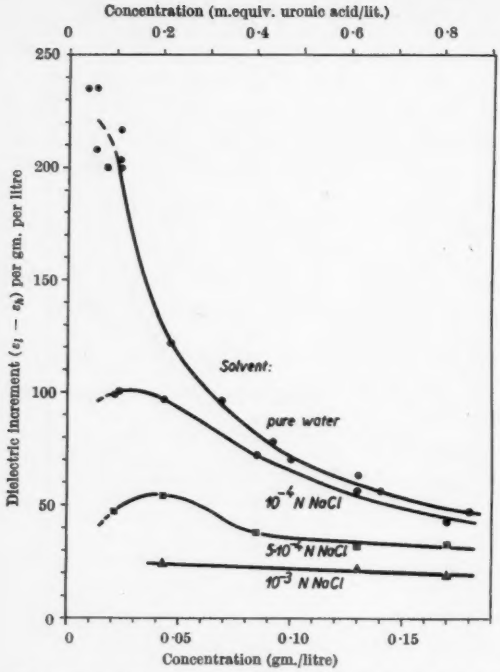

Fig. 1. Dielectric increment per gm. per litre of sodium alginate in water and at various sodium chloride concentrations. *p*H about 6

stant at high frequencies (ε_h) and low frequencies (ε_l) relative to the dispersion region was obtained graphically. The difference between ε_l and ε_h is the increment used for further calculation.

Fresh solutions of sodium alginate (purified by high-speed centrifuging and dialysis, freeze-dried, number average molecular weight approximately 50,000)[1] in pure water were investigated during the time interval 2–8 hr. after dissolution. Solutions in 10^{-4}, 5×10^{-4} and 10^{-3} *N* sodium chloride were prepared by dilution from 0·04 per cent alginate stock solutions in the respective solvents. Stock solutions were stored at approximately + 4° C. and the dilutions were examined during the time interval 1–3 days after preparation of stock solution. Sodium alginate was used in the concentration-range 0·01–0·2 gm./litre.

The results obtained are shown in Fig. 1. The dielectric increment has been given as the reduced quantity, increment per gm. per litre, I_g. With most proteins and simple dipolar ions studied[2] the increment in pure aqueous solution is a linear function of concentration and thus I_g is a constant. With polyelectrolytes this is not the case, and the considerable increase of I_g for alginate in pure water with decreasing concentration is a typical finding. If the increment is assumed here simply to be a reflexion of the net (negative) charge of the polyion, then the qualitative interpretation of the shape of the curve in pure water is a decreased polyion – counter ion association with decreasing concentration of polyions. At very low concentrations, namely, less than 0·02 gm./litre, I_g tends towards a constant value (although the errors of measurement are high at the lowest concentrations: approximately ± 20 per cent at 0·01 gm./litre as compared with approximately ± 3 per cent at 0·1 gm./litre). This implies that at concentrations lower than 0·01 gm./litre, the (negative) charge of the polyion approaches its maximum value and thus the interaction between polyions and counter ions approaches complete disassociation. The increment will then be a linear function of concentration.

When the solvent contains small amounts of sodium chloride, the higher the sodium chloride content the lower will be the dielectric increment. In accordance with the above argument, this is due to the electrostatic screening of the excess of counter ions, that is, a decrease of the net charge of the polyions with increasing counter-ion concentration. With 10^{-4} and 5×10^{-4} *N* sodium chloride, the curve shows a maximum, which is displaced towards higher polyion concentration with increasing counter-ion concentration. This effect may be interpreted as being due to the competing actions of increased screening with increased counter-ion concentration, leading to a decrease of the increment, and the tendency towards a higher I_g value with decreasing polyion concentration, as stated above. The former effect will prevail at polyion concentrations lower than those of the maximum of the curve. At the maxima the concentration of polyions and counter ions is of about the same order on the basis of equivalents per unit volume.

With the highest sodium chloride concentration studied, 10^{-3} *N*, I_g approaches a constant value. Thus polyion – counter ion association occurs at all concentrations and the net charge of the polyion approaches zero. At this concentration of counter ions there is still a residual increment. Unfortunately, it does not seem possible with present methods to make dielectric measurements at higher simple electrolyte concentrations than approximately 10^{-3} *N*.

Towards higher polyion concentrations all the curves show a tendency to extrapolate to a common and constant value of I_g. This corresponds to the state just mentioned, due to the prevalence of polyion – counter ion association.

In the region of low concentration studied here, the results are in general agreement with those obtained in other studies of polyelectrolytes[4]. My curves show striking resemblance to curves obtained when plotting reduced viscosity vs. concentration for a number of polyelectrolytes under similar experimental conditions[5]. A similar interpretation to that given here for the dielectric increment has been given for the electroviscous effect.

Thanks are due to Alginate Industries, Ltd., England, for the gift of a sodium alginate sample ("Manucol SS/LH 30591") and to the Karolinska Institutet and the Thérèse and Johan Andersson Foundation for financial support.

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July 17.

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FORTHCOMING EVENT

Monday, December 20

OPERATIONAL RESEARCH SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Meeting on "The Accuracy and Function of Time Study".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade B (with an honours degree in mathematics or engineering, and with suitable teaching experience), IN THE DEPARTMENT OF MATHEMATICS—The Registrar, College of Technology and Commerce, The Newarke, Leicester (December 28).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in mechanical or chemical engineering or equivalent qualification, and some postgraduate research experience), at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead a research team investigating heat transfer in heat exchange plant—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4401/54 (December 29).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering or equivalent qualifications) at the Mechanical Engineering Research Laboratory, East Kilbride, near Glasgow, to initiate research into fundamental factors underlying the wear and lubrication of internal combustion engines, using modern techniques (e.g., radioactive tracers)—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4405/54 (December 30).

ANALYTICAL CHEMIST (with a degree in chemistry or equivalent qualification, and preferably with experience in analysis of compounded materials) in the Plant Protective Chemistry Section, for work which will consist mainly of analysis of spray materials and residues—The Secretary, East Malling Research Station, near Maidstone, Kent (December 31).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree (chemistry or botany), or at least the general certificate of education at advanced level), IN THE CHEMISTRY SECTION, to work mainly on the effects of crop residues on the soil—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (December 31).

CHEMICAL ENGINEER, Senior Scientific Officer grade (with a first- or second-class honours degree in chemical engineering or equivalent, and postgraduate experience in development work, including design of pilot units), at a Ministry of Supply Establishment located in S.W. England, to be concerned with the development of chemical processes involving semi-technical research and design and operation of pilot units—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.806/54A (December 31).

CHEMIST (with a first- or second-class honours degree or equivalent qualification in chemistry, and preferably with postgraduate experience in physical analytical methods, micro-analysis, chromatography, corrosion of metals or biochemistry) at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to take charge of a chemical laboratory, and work on chemical and biochemical problems associated with the study of deterioration under tropical conditions of materials and stores of all types—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.816/54A (December 31).

LABORATORY TECHNICIAN IN THE DEPARTMENT OF CHEMISTRY, Potchefstroom University for Christian Higher Education, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, December 31).

PHYSICAL CHEMIST (with at least a good honours degree) for investigation on macromolecular substances of biological origin by physical methods—The Chester Beatty Research Institute, Fulham Road, London, S.W.3, quoting "Physical Chemistry" (December 31).

PHYSICISTS and CHEMISTS, to carry out research into glass-making problems—The Secretary, British Glass Industry Research Association, "Elmfield", Northumberland Road, Sheffield 10 (December 31).

PHYSICIST or ELECTRICAL ENGINEER (with a knowledge of electronics, and preferably familiar with electrical instrumentation and measurement techniques), for recording work on rocket motors; and PHYSICISTS or MECHANICAL ENGINEERS for (*a*) experimental and theoretical work on the development of components for liquid and solid propellant rocket motors, and (*b*) for work on heat transfer problems in rocket motor nozzles, at the Royal Aircraft Establishment, Rocket Propulsion Department, Westcott, Bucks—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.346/54A (December 31).

ASSISTANT EXPERIMENTAL OFFICER (science graduate) to do chemical analysis associated with grassland and other research—The Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr (January 1).

ENGINEER (with a good honours degree in mechanical engineering or equivalent professional qualifications, proved research ability and preferably experience in the field of the strength of materials), at the Central Research Establishment, National Coal Board, to lead a group carrying out research on coal cutting—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/891 (January 1).

RESEARCH FELLOW IN RADIATION BIOLOGY, and a RESEARCH FELLOW IN BIOCHEMISTRY—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1 (January 1).

RESEARCH WORKER (with a university degree, preferably in forestry, and with some practical forestry and research experience), to undertake a special study of the problem of planting mining refuse heaps in Scotland—The Secretary, The University, Edinburgh (January 1).

LECTURER (with a good honours degree) IN PHYSICS, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (January 3).

MATHEMATICIANS (with a first- or second-class honours degree in mathematics) at Ministry of Supply Research and Development Establishments in Southern England, for work on a wide range of problems chiefly concerned with aircraft, radio and radar equipment and armaments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.355/54A (January 7).

PHYSICIST (with a good honours degree in physics, and at least two years experience in radiological physics), at the Combined Military Hospital, Rawalpindi, Pakistan—The Recruitment Officer, Education Division, Office of the High Commissioner for Pakistan, 39 Lowndes Square, London, S.W.1 (January 7).

CHAIR OF PHYSICAL METALLURGY—The Registrar, The University, Sheffield (January 8).

SCIENTIFIC OFFICER (with a first- or second-class honours degree in an approved scientific subject or other approved equivalent qualification, and preferably with previous industrial experience) IN THE DEPARTMENT OF INDUSTRIAL AND FORENSIC SCIENCE of the Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast, N. Ireland (January 10).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in mathematics, physics or engineering, or equivalent qualifications) at the Mechanical Engineering Research Laboratory, East Kilbride, near Glasgow, to lead a team preparing tables of thermodynamic properties—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4402/55 (January 18).

PRINCIPAL or SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or physical chemistry or equivalent qualification) at the Radio Research Station, Department of Scientific and Industrial Research, Ditton Park, Slough, Bucks, to lead a small, but expanding group investigating the fundamental electrical properties at high frequencies of materials of interest in radio applications and the relation of these properties to their physical and chemical structure—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4399/55 (January 20).

RESEARCH ASSISTANT (with a first- or good second-class degree in botany or geography, and with ecological or physiographical interests) IN ECOLOGY, for work on *Spartina* colonization of coastal areas—The Secretary and Registrar, The University, Southampton (January 31).

LECTURER (graduate in science or agricultural science) IN BOTANY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 1).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary, The University, Edinburgh (February 14).

LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—The Secretary, The University, Edinburgh (February 28).

ASSISTANT CONSERVATORS (with either a degree in forestry or an honours degree in natural science, with botany as a special subject) OF FORESTS, in the Gold Coast Local Civil Service—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.61/13/02.

ASSISTANT LECTURERS, Grade B, IN THE DEPARTMENT OF CHEMISTRY AND APPLIED CHEMISTRY—The Principal, Royal Technical College, Salford, 5.

CYTOLOGIST, for chromosome studies—The Sherardian Professor of Botany, The University, Oxford.

ENTOMOLOGISTS (with an honours degree in zoology, and training in entomology) in the Department of Tsetse Control, Gold Coast Local Civil Service, to investigate various aspects of the bionomics and ecology of tsetse flies in relation to man and animals, and to supervise control measures under the direction of the Director of Tsetse Control—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.77/13/01.

LABORATORY ASSISTANT (with a general degree in science or agriculture, with main interest in chemistry, or an honours degree in chemistry) IN THE DEPARTMENT OF AGRICULTURE, Kenya, to carry out investigational work on problems of agricultural chemistry related to coffee culture—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/7/09.

LABORATORY TECHNICIAN (with experience in the use of routine apparatus, and preferably with biochemical or chemical training) IN THE PHYSIOLOGY DEPARTMENT—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

LECTURER (graduate in chemistry or biochemistry and experience in the food industry, preferably in the technology of edible oils and fats or of cereals)—The Registrar, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

MASTER to teach BIOLOGY to Scholarship level—Headmaster, Downside School, Stratton-on-the-Fosse, Bath, Somerset.

MATHEMATICAL PHYSICISTS (with a first- or second-class honours degree in mathematics or physics, together with some years appropriate postgraduate research experience), for work in one of the following fields: astrophysics, fluid dynamics, nuclear physics or statistics—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 283/WGE/2.

PHYSICIST (with an honours degree, and an interest in classical physics, fluid mechanics and statistical analysis) to work with a small team engaged on a long-term study of the principles of operation of paper-making machines, and, in particular, of fluid flow of pulp suspensions—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

RESEARCH ASSISTANT (female) (preferably B.Sc. (bacteriology)), for duties concerned with research on serology of viruses—The Secretary, Foot and-Mouth Disease Research Institute, Pirbright, Surrey.

RESEARCH ASSISTANT (Ph.D. standard), for work on reaction kinetics at gas-solid interfaces—Dr. Tomkins, Imperial College, London, S.W.7.

RESEARCH ASSISTANTS (with a higher or ordinary national certificate in science, technology or engineering, Inter.B.Sc., or equivalent qualification) IN THE FUEL TECHNOLOGY SECTION of the Physics Department—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Fuel Technology".

TECHNICIAN (with G.C.E. advanced level in mathematics or physics), for work in the isotope laboratory—The Director, Radiotherapeutic Research Unit, Hammmersith Hospital, Ducane Road, London, W.12.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

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